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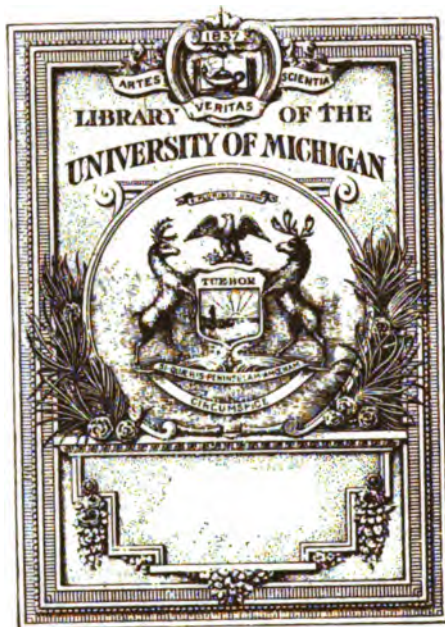
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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 39



PROCEEDINGS
OF THE
GOOD ROADS INSTITUTE

HELD AT THE
UNIVERSITY OF NORTH CAROLINA

MARCH 17-19, 1914

*Held under the Auspices of the Departments of Civil and
Highway Engineering of the University of North Carolina and
The North Carolina Geological and Economic Survey*



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PROCEEDINGS
OF THE
GOOD ROADS INSTITUTE
HELD AT THE
UNIVERSITY OF NORTH CAROLINA
MARCH 25, 1911

*Addressed on January 11, 1911, by the UNIVERSITY OF NORTH CAROLINA
TO THE COMMISSIONERS OF THE UNIVERSITY OF NORTH CAROLINA, and
THE NORTH CAROLINA TOWNSHIP AND TOWNSHIP SOCIETY*



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Some of the Engineers who attended the Good Roads Institute at the University of North Carolina, March 17, 18 and 19, 1914.

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., November 1, 1914.

*To His Excellency, HONORABLE LOOKE CRAIG,
Governor of North Carolina.*

SIR:—There was held in March of this year, at the University of North Carolina, under the auspices of the State University and the North Carolina Geological and Economic Survey, a Good Roads Institute, which proved to be of so much interest to those who attended that I believe the proceedings of this Institute should be put in such shape so that they can be distributed to the road engineers and superintendents of the State. I have, therefore, had the proceedings compiled and herewith submit them for publication as Economic Paper No. 39 of the publications of the North Carolina Geological and Economic Survey.

Very respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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PROCEEDINGS
OF
Good Roads Institute
HELD AT
UNIVERSITY OF NORTH CAROLINA
March 17-19, 1914

INTRODUCTION.

There was inaugurated at the University of North Carolina, March, 1914, an Institute that will probably become one of the more important phases of the extension work organized by the University. This refers to the Good Roads Institute held on March 17, 18, and 19, 1914, under the auspices of the Department of Civil and Highway Engineering of the University and the Highway Division of the North Carolina Geological and Economic Survey.

The object of the Institute was to bring together at the University the engineers and superintendents who have the direct charge of the road work throughout the different counties in North Carolina for a discussion of the various road problems and for consultation regarding peculiar road problems that the different men have to consider. Invitations were sent to engineers and superintendents of all the counties and the boards of county or road commissioners, by whom these men are employed, were urged to instruct them to attend the Institute and that their attendance be considered part of their official duties. In some instances this was done and the counties bore all the expenses of the engineers and superintendents to the Institute. It is believed that this Institute, as it is made an annual occurrence, will become a clearing-house for road problems in this State.

Although the attendance at this first Good Roads Institute was not large the men were from many different sections of North Carolina and were a representative body of those in charge of the road work of the State. There were fifty-four registered at the Institute from the following twenty-four counties:

Cabarrus
Cleveland
Craven
Davidson
Duplin
Durham
Edgecombe
Forsyth

Gulford
Halifax
Iredell
Madison
McDowell
Mecklenburg
New Hanover
Northampton

Orange
Robeson
Rockingham
Rowan
Rutherford
Scotland
Vance
Wake

Before the close of the Institute, those attending passed a strong resolution, urging the University and the Survey to make it an annual affair, and, in accordance with this request, the officials of these two institutions have arranged for holding a Good Roads Institute annually at the University of North Carolina. The scope and efforts of the Institute will be enlarged, and it is expected that in 1915 the Institute will be of at least a week's duration.

Many valuable papers were presented at the Institute that make a valuable addition to good roads literature, and these papers, as far as possible, are published at the end of the report of the proceedings of the Institute.

In arranging the program it was realized that certain rules and regulations would have to be in vogue similar as in regular university work. The lectures began promptly at the hour designated and the Institute was enabled to carry out the program almost in its entirety.

The following are the names of those who registered at the Road Institute:

John M. Ambler, Highway Engineer, Winston-Salem, N. C.
A. H. Carr, Durham, N. C.
George M. Carson, Road Superintendent, Marton Township, Marion, N. C.
J. B. Clingman, Road Engineer, Madison County, Marshall, N. C.
Collier Cobb, Jr., Chapel Hill, N. C.
A. E. Croom, Road Foreman, Wallace, N. C.
E. C. Belvin, Highway Engineer, Durham, N. C.
W. A. Broadway, Mooresboro, N. C.
D. Tucker Brown, Highway Engineer N. C. Geological and Economic Survey, Chapel Hill, N. C.
R. T. Brown, Highway Engineer and Superintendent, Orange County, Hillsboro, N. C.
R. A. Burnett, Road Superintendent, New Hanover County, Wilmington, N. C.
J. A. Davidson, County Superintendent, Greensboro, N. C.
S. B. Dameron, Reidsville, N. C.
Brent S. Drane, Engineer, Charlotte, N. C.
W. P. Eddleman, County Superintendent, Shelby, N. C.
W. S. Fallis, Highway Engineer, Franklinton, N. C.
B. L. Field, Chapel Hill, N. C.
G. W. Flowers, Durham, N. C.
A. P. Gilbert, representing Gallion Iron Works, Durham, N. C.
H. W. Harkey, Charlotte, N. C.
T. F. Hickerson, Highway Engineer, Chapel Hill, N. C.
N. C. Hughes, Jr., Highway Engineer, Weldon, N. C.
T. P. Jenkins, Road Superintendent, Tarboro, N. C.
F. Swindell Kluttz, Concord, N. C.
R. L. Lasley, Wentworth, N. C.
E. W. Lupton, Chapel Hill, N. C.
Lee W. Lynch, Highway Engineer, Forest City, N. C.
L. H. Lyon, Wilmington, N. C.
M. G. Markham, County Commissioner, Durham, N. C.

F. H. May, Wendell, N. C.
 J. S. Miller, Jr., Philadelphia, Pa. Barber Asphalt Co.
 George N. Moore, representing Robeson Process Company, Pennington, N. J.
 Ira B. Mullis, Highway Engineer, Lumberton, N. C.
 B. McAllister, Wilmington, N. C.
 R. A. Patterson, Salisbury Metal Culvert Co., Salisbury, N. C.
 J. L. Phillips, Assistant Engineer, Orange County, Hillsboro, N. C.
 J. T. Plott, Statesville, N. C.
 J. M. Pollard, Superintendent of Roads, Durham County, Durham, N. C.
 Joseph Hyde Pratt, Chapel Hill, N. C.
 James B. Price, Superintendent of Roads, Rockingham County, Madison,
 N. C.
 A. A. Reed, Chapel Hill, N. C.
 R. A. Reed, Winston-Salem, N. C.
 C. S. Reeve, U. S. Office of Public Roads, Washington, D. C.
 J. T. Rogers, County Commissioner, Durham, N. C.
 C. L. Sapp, Road Engineer, Rich Square, N. C.
 J. B. Scarborough, Chapel Hill, N. C.
 G. A. Simpson, Laurel Hill, N. C.
 J. H. Slaughter, representing Harry Bros. Co., Lexington, N. C.
 Q. E. Smith, Highway Commissioner, Concord, N. C.
 R. E. Snowden, Highway Engineer, New Bern, N. C.
 — — Sumwalt, Dixie Culvert Co., Greensboro, N. C.
 W. M. Ward, Newton, Iowa.
 F. F. Wetmore, Highway Engineer, Lumberton, N. C.
 W. Staley Wicker, Chapel Hill, N. C.
 J. E. Wright, Road Superintendent, Laurinburg, N. C.

PROCEEDINGS OF THE INSTITUTE

The Good Roads Institute was called to order by the State Geologist in the auditorium of the Peabody Building, at nine o'clock Tuesday morning, March 17, 1914. The members of the Institute were welcomed to the University by Acting President Edward K. Graham, in his usual happy vein. He stated that it is the University's purpose to serve the State in every way leading to its upbuilding and the promotion of the welfare and happiness of its people; that few people were rendering the State a greater or more faithful service than the road engineers, and the University feels honored in welcoming them to her doors.

After the address of Mr. Graham the following program was carried out:

PROGRAM.

TUESDAY, MARCH 17, 1914.

- 9:15 a. m. General Principles of Road Location, Prof. Wm. Cain.
 9:30 a. m. Practical Considerations Governing the Location of Roads, D. Tucker Brown, Road Organizer and Engineer of the North Carolina Good Roads Association.
 Discussion.

- 10:30 a. m. Road Surveying and Mapping, Prof. T. F. Hickerson.
Discussion.
- 12:00 m. Practical Demonstration of the Abney Hand Level, Professor
T. F. Hickerson.
- 2:30 p. m. The Economics of Road Construction, W. S. Fallis, Road En-
gineer.
- 7:30 p. m. Lecture on "Asphalt from its Source to the Pavement," (illus-
trated with moving pictures), J. S. Miller, Jr.

WEDNESDAY, MARCH 18, 1914.

Surfaced Roads

- 8:30 a. m. Sand-clay, Topsoil and Gravel Roads, Joseph Hyde Pratt, State
Geologist.
Discussion.
- 10:00 a. m. Waterbound and Bituminous Macadam Roads (illustrated), Mr.
C. S. Reeve of the U. S. Office of Public Roads.
Discussion.
- 11:30 a. m. Dirt Roads, Joseph Hyde Pratt.
Discussion.

Drainage of Roads.

- 2:30 p. m. Drainage of Roads, T. F. Hickerson.
- 3:00 p. m. County Bridges, Jno. M. Ambler, Road Engineer.
- 3:30 p. m. Culverts, R. T. Brown, Road Engineer.
Discussion.
- 4:00 p. m. Demonstration of Use of Road Drag, R. T. Brown, Road Engi-
neer.
- 7:30 p. m. Good Roads in Foreign Lands (illustrated), Professor Collier
Cobb.

THURSDAY, MARCH 19, 1914.

Road Machinery and Supplies.

- 8:30 a. m. Road Building Machinery, N. C. Hughes, Jr.
Discussion.
- 9:30 a. m. Road Surfacing Materials in North Carolina. Professor Collier
Cobb.
- 10:00 a. m. Maintenance of Roads, R. A. Burnett, Road Superintendent.
Discussion.
- 11:00 a. m. Organization of Road Forces, Prof. M. H. Stacy.
Discussion.
- 12:00 m. The Road Contractor, Brent Drane.
- 12:30 p. m. Natural Sand-clays in North Carolina Piedmont Belt, by Mr.
John E. Smith.
- 2:30 p. m. Visitors shown over the University Buildings.

There were excellent discussions of nearly all the papers presented and the general feeling of those in attendance was that the Institute was a success and would be very beneficial in the public road work of North Carolina.

During the morning session on Thursday, March 19th, the following resolutions were introduced and unanimously passed:

Resolutions.

I. *Resolved*, That we express our thanks and appreciation to the Departments of Civil and Highway Engineering of the University and the North Carolina Geological and Economic Survey for the benefits which we have derived from the Good Roads Institute.

II. *Resolved, further*, That it is our belief that such an Institute is of very great value to the good roads work of North Carolina, and it is also our belief and desire that the Institute be made an annual occurrence, and we herewith respectfully request the President of the University and the Director of the North Carolina Geological and Economic Survey that they seriously consider the holding of an annual Good Roads Institute at the University.

There are given on the following pages the papers read at the Institute and other data and information submitted by the different members in attendance.

Considerations Governing the Proper Location of Roads.

BY D. TUCKER BROWN, ORGANIZER AND ENGINEER OF THE NORTH CAROLINA GOOD ROADS ASSOCIATION.

The proper location of a road consists in determining and marking out those points on the ground through which the road should pass in order to satisfy as nearly as possible the requirements of an ideal road.

These requirements for an ideal road may be divided into two groups:

- (1) Those which make a road perfect from a technical standpoint; and
- (2) Those which make a road perfect from the standpoint of serviceability to the country, both in regard to local and through traffic.

A section of the country is seldom found in which the requirements of both groups may be satisfied, and as there are certain limits to each, those of the first being more definite and important, it is essential that they be more carefully observed.

Upon the first group depends the cost of construction, maintenance and transportation; upon the second, depends the convenience to the community, and it will be readily seen that the effect of observing the first will be lasting while that of the second will be only temporary, if there is the proper development in the section through which the road passes.

In the first group these requirements for an ideal road are:

- (1) As to direction: that it should be straight.
- (2) As to grade: that it should be level.
- (3) As to cost: that the amount of work on grading, draining, mechanical structures, and surfacing should be the *least* that will make the road what it ought to be.
- (4) As to exposure: that it should have the best.

Those of the second group are:

- (1) That it should be of equal benefit to all.
- (2) That it should shorten the distance from every man's house to the point where he wishes to go.
- (3) That it should run through every man's land where he thinks it should.
- (4) That it should shorten the distance between communities and markets.

It is evident, that to satisfy the requirements of the first group it is necessary that the ground between the termini of the road be a straight level ridge with adequate drainage to either side and sufficient exposure to the sun, and that this condition is rarely ever met with in practice, and certainly not on roads of any great length. The country is usually so broken by mountains and valleys, hills and vales, as to present great difficulties to securing a location which will even approach the ideal, and the question which confronts the locating engineer is how to secure the best route that the topography of the country will permit, without sacrificing to too great an extent any of the requirements for an ideal road; and to enable him to accomplish this it is necessary that he have a general knowledge of those features of the earth's surface which govern the location of roads, and a more thorough knowledge of the topography of the country immediately adjacent to the proposed route.

I think it an undisputed fact that:

- (1) Hills are the natural enemies to the road maker; and
- (2) Water courses his guides and assistants.

It is, therefore, essential that he study their relations to one another, and the advantages and disadvantages which they present; and, in this connection, the following facts will be of inestimable value:

- (1) If a principal ridge is met by two secondary ridges at the same point, that point is of maximum height.
- (2) If a principal ridge is met by two valleys at the same point, that point is of minimum height.
- (3) If a principal ridge is met by a secondary ridge and a valley, nothing can be inferred.
- (4) If two parallel streams with a ridge between suddenly diverge, the ridge between will be found to increase in height.
- (5) If two parallel streams with a ridge between suddenly converge, the ridge between will be found to decrease in height.

For the purpose of determining the proper route through any section of country, so far as the requirements of group I are concerned, it is customary to proceed in the following manner:

A reconnaissance survey should be made of the region through which the road is to pass, and is generally made by the eye alone, without instruments. It is intended to be only approximate, and to serve to determine through what points routes should be instrumentally surveyed; and no time or labor should be spared in these first explorations, as they will save much expense in subsequent detailed surveys.

Governing points will be found through which the road must pass, such as a low gap in a range, a narrow part of a river suitable for a bridge, etc., and between these ruling points the straight line joining them is marked out on a map and the routes adopted for instrumental surveys must continually tend to coincide with it, except when deflected to the right or left by weighty reasons, such as the topography of the country demands.

If a topographical map is at hand it will be of great assistance, and the facts mentioned heretofore relative to hills and water courses will enable one to read the map more readily and accurately; and it is not infrequent that sufficient information may be obtained from it to enable one to decide what routes are the best to survey with the instruments.

After having studied carefully the topographical features of all routes and decided upon the ones to be surveyed with instruments, the next step consists in making the actual detail surveys. There may be necessary only one, and again as many as five, depending entirely upon how many routes meet so nearly the requirements as to make it impossible to decide upon the proper one without more specific information than can be obtained by a reconnaissance survey.

These surveys, in order that they may be complete, should consist of a transit line, level line, cross section notes, classification notes, topographical notes and notes on all conditions which may in any way affect the construction or maintenance of the road, and from the information obtained, the maps, profiles and estimates should be made.

After the surveys are complete, the work is in the correct form to enable one to determine which of the surveys is the best, as to alignment, grades, cost and exposure, and in general the following limits should be carefully observed on roads which are to be permanently improved.

The radius of no curve should be less than 100 feet, and if less the roadway should be widened throughout the length of the curve.

No grade should be less than 1 per cent nor greater than $4\frac{1}{2}$ per cent. Grades between these limits provide ample drainage and there is little danger of wash due to the swiftly flowing surface waters.

The cost of construction of a road should be governed entirely by the saving made possible by any form of improvement.

If possible, try to keep roads off of northern and western slopes of mountains, and if it is necessary to locate on those slopes, always try to have light grades, for if you do not, the snow and ice will be a continual menace during winter months.

Road location can therefore be summed up as follows so far as alignment, grades, costs and exposures are concerned:

To what extent may any one requirement of group I be sacrificed in order that one or more of the others of group I may be more nearly satisfied, and the proposed location still remain within the limits of economy so far as the road as a whole is concerned? And the answer is, that if the alteration of any requirement increases the sum of the costs of construction, of maintenance, and of transportation above what it was before the change; then the change is unwarranted, and vice versa.

With the surveys spoken of heretofore completed, the cost of construction can be estimated very closely; but to determine the costs of maintenance and transportation, it is essential that a traffic census be taken.

This consists of an estimate from actual observation, if an old road is to be improved; and of approximations based upon the traffic that would be benefited, if a new road is to be opened; of the tonnage, number and class of teams which do or may be expected without much doubt to pass over the road in a specified length of time, and it must be remembered that the traffic on a road will be materially increased by any form of improvement that will reduce the cost of hauling.

After estimating the traffic we are in a position to determine the costs of maintenance and transportation on any class of road for that amount of traffic and are also able to tell whether or not any contemplated improvement is a good investment and if not, what improvement would be?

In this connection, I will say that any improvement by which the interest on the money spent for construction plus the cost of maintenance and transportation is reduced should be undertaken without delay.

To demonstrate, suppose it was proposed to make a sand-clay road of an old earth road 10 miles long and that the following assumptions were true:

	<i>Earth.</i>	<i>Sand-clay.</i>
Six per cent interest on original cost one year	\$180.00	\$720.00
Cost of maintenance one year.....	250.00	800.00
Cost of transporting per year 20 tons per day at 10 cents per ton mile on sand-clay; 30 cents per ton mile on earth.....	21,900.00	7,300.00
	<hr/> \$22,330.00	<hr/> \$8,820.00

It will be readily seen that a community could easily afford to spend the difference between \$22,330 and \$8,820, or \$13,510 in improving the road for a traffic of 20 tons per day; and this does not take into account the possible development along the road after its improvement.

I now come to the consideration of the effect which the requirements of Group 2 should have on those of Group 1.

The requirements of Group 2 we can *never* hope to satisfy, for in each locality there are not only physical impossibilities but human impossibilities, and to carry out suggestions of those who have never seen a properly located road, but *know* every essential detail, would require the performance of miracles. I, therefore, feel a delicacy in dealing with Group 2. There are always so many people who can tell you the cheapest, shortest and most level route, and it is peculiar to note that their idea of the best route is the one which passes through their land where they wish it; that is, if they want the road, and misses their land entirely, if they do not want it.

The effect of satisfying local communities or parties so often necessitates a sacrifice of some one of the essential requirements of Group 1 and in consequence burdens the community with a road either costly in construction or maintenance, and I think it is a condition seldom found that we can afford to build a road connecting important points and sacrifice to any great extent its alignment, its grades, its cost, or its exposure, for even a rather thickly settled community. It is far better that less expensive roads be built from the main roads into such communities.

It may be well to note here, and it is a good point to bear in mind, when making locations, that a great deal of trouble with people may be avoided so far as right of way is concerned, if you find out before you run your line just where they wish it located. It frequently happens that through a man's land are two routes equally as good and his choice may be one of them, and the other may be just what he doesn't want. Furthermore, if you find out that the route you *do not* want is the one he *doesn't* want, survey it, and by so doing you can usually obtain the proper one without right of way cost.

I feel that we will never get a road where it will remain within the economic limits of the requirements of the first group, and satisfy to a great extent those of the second group, until we have the proper road laws, an absence of politics in road questions, and citizens who are willing to leave their road problems to those who have studied them.

However, I shall say a few words which I hope will be a help toward enlightening the people to the fact that good roads are money well invested, and how far they can afford to sacrifice the requirements of Group 1 for those of Group 2.

The question which is of paramount importance in making location in so far as the requirements of Group 2 are concerned is:

Which route (if several are considered) will be of the most benefit to the most people?

The customary answer among the laymen is: The route which passes the most homes.

I most emphatically insist that this answer is absolutely wrong and in answering the question will say that no change which increases the cost of construction or maintenance of any road should be made for the benefit of any person or persons, unless the increase in tonnage due to such change, is so great as to make the difference between the cost of hauling it over the unimproved and the improved road, greater than the interest on the additional cost of construction, plus the increased maintenance cost, plus the increased cost of transporting through tonnage over the additional section of improved road. For demonstration, suppose it is proposed to build a road between two towns or thickly settled communities which I will designate as A and B, and that the distance from A to B is D miles; also that at some point C not on the direct line from A to B there is another thickly settled community, and to go by C would increase the length of the road from D to E mile. Suppose further that the tonnage from A to B is T ton per year, that from A to C is T_1 tons per year, and from B to C is T_2 tons per year and that for simplicity the cost per mile for either route is N dollars and the maintenance cost for either route per mile per year is M dollars, that R is the usual rate of interest and X the cost of hauling per ton mile on improved road and Y cost on unimproved road.

Then if $EY (T_1+T_2) - EX (T_1+T_2) > (NE-ND) R + (ME-MD) + (TE-TD)X$, the route by C is justifiable and vice versa.

It must be remembered in making the foregoing deductions that a very comprehensive traffic census is necessary, and that the growth of traffic should be most carefully approximated. The same principle will apply to any routes of equal length where the difference in cost of construction, transportation and maintenance is due to excessive grades; and should a case of this kind arise, it will be well to be *most* careful in the estimate of the cost of maintenance, which increases very rapidly and *not* in proportion to the increase in grade.

I have not in the above taken into consideration the people who might have been benefited had they not been at A, B, or C, but at some intermediate point; the principle is the same, however.

It might be well to show here a method of determining the region over which the benefits of a good road would extend.

In Fig. 1, let A B represent a portion of an improved road, lying between the two points A B at which cross roads come in. It is required to fix the points C C D D so that lines drawn from C and C to A, and from D and D to B, shall define this tributary area. BC or AD is to be found in terms of AB.

The ratio of improvement of the new road compared with the old, we will say is 2; i. e., it costs one-half as much to haul over improved as it does

over unimproved. If then, X plus $\frac{n}{2}$ is less than M , it will cost less to make

the circuit from C to A through B than over an unimproved road direct from C to A; and the cost of transportation on both routes will be equal when

$$X + \frac{n}{2} = M.$$

But in A. B. C.

$$M = (X^2 \text{ plus } N^2)$$

Substituting

$$X \text{ plus } \frac{n}{2} = (X^2 + N^2)$$

Whence we obtain the value $X = \frac{3}{4}N$.

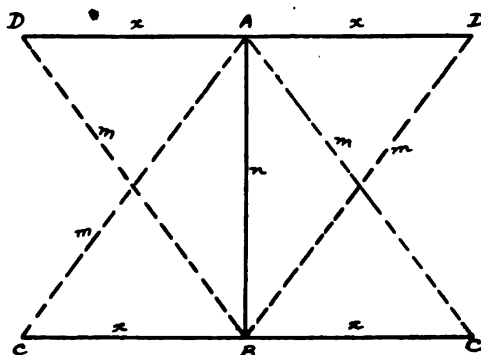


FIGURE 1.

Therefore from A and B set off at right angles to AB, BC, and AD each equal to $\frac{3}{4}$ AB, join AC and BD; and the area included will be that within which it would cost less for the inhabitants to use the improved road, though with increased distance, than to pursue the direct but unimproved road.*

It is to be regretted that our people have not realized the necessity of a traffic census on all roads which they contemplate improving permanently.

In conclusion, I shall call your attention to several points which, if borne in mind, will be of assistance to you in making locations.

- (1) When possible cross streams at narrow points and at right angles.
- (2) Make openings for all streams amply large.
- (3) When following or crossing a stream be sure that your grade line is well above high water.
- (4) If necessary to ford a stream, do so at a point where the least length of road will be subject to overflow.

*LeCount, Treatise on Railways.

- (5) Make your stream crossings as well as gaps governing points in your survey.
- (6) Cross streams where you can secure solid foundations.
- (7) Generally speaking, when crossing a ridge parallel to a stream, ascend down stream and descend up stream. This will shorten your line.
- (8) Compensate for curves on maximum grades.
- (9) When following streams the least expensive line is usually the one just above high water line.
- (10) It is economy practically in all cases to cross a ridge at its lowest point.
- (11) The æsthetic features should receive consideration but not at the expense of the serviceability of the road.
- (12) Above all things, if you are ever called upon to locate a mountainous road, *always* go to the gap and work down on the proper grade to the stream below.

ROAD SURVEYING AND MAPPING.

By T. F. HICKERSON, ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF NORTH CAROLINA.

The complete and thorough survey for a road includes in general, three engineering operations: (1) The reconnaissance; (2) the preliminary survey; (3) the final location.

The reconnaissance is a general and somewhat hasty examination of the country through which the road is to pass, for the purpose of acquiring a mental picture of the "lay of the land" and noting the *governing points* of the probable route, such as best crossings of streams, or ridges, and any point where the line will be compelled to pass.

The following instruments may be useful: barometer, hand level, pocket compass, and pedometer. A map of the territory, especially a United States Topographic map, will always be helpful.

The preliminary survey consists of an instrumental examination of the country along the proposed route for the purpose of obtaining such details of directions, distances, elevations, topography, etc., as may be necessary to prepare a map and profile of the route, make an approximate estimate of the cost of constructing the road, and furnish the data from which to definitely locate the line should the route be adopted.

The survey is more or less elaborate according to circumstances. No general rule for the exact order of procedure in every case can be given. In mountainous country where grade is the primary consideration, the first step in the preliminary survey would probably be a lay out of the center line on a certain grade by means of an Abney hand level or the gradienter attachment on a transit; then a survey with the transit and level is made. In flat country where alignment is the primary consideration, a transit survey for directions is the first step.

In many cases the route is definite enough to warrant laying out the curves while making the preliminary survey (or else making proper allowances for them in the stationing), thus obviating the necessity of the final location survey. A strong point in favor of this is that the profile of the center line will then be continuous. There is a temptation, however, to do this too often and much time is wasted in making future changes in the accurately located line or else too many short curves are used. Thus, the three curves ab, bc, and cd (Fig. 2) might have been laid out when, if a map had been made of the

transit line, a single ABC could have been selected to fit the conditions of the ground and give much better alignment.

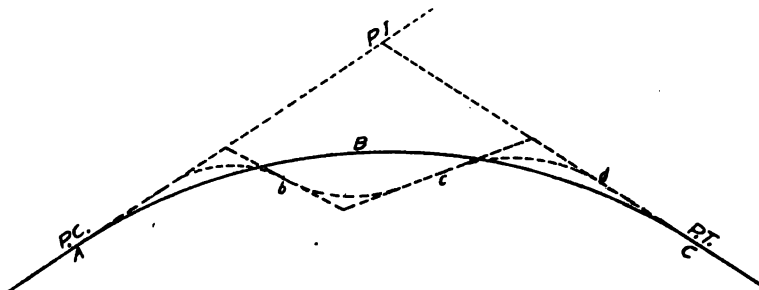


FIGURE 2.

In making a survey for the relocation of an old road, the following method is very satisfactory. It consists in making a survey of the old road and noting where and to what extent changes are desirable and feasible. Then a map is made to a scale of 1 inch=50 feet (not smaller than 1 inch=100 feet). The new road is now laid out on the map and distances and angles scaled so that the data are sufficient to lay it out on the ground in the proper place.

A convenient method of keeping notes of the transit survey is called the "deflection method" and is illustrated below. The instrument is supposed to be set up at every change in direction.

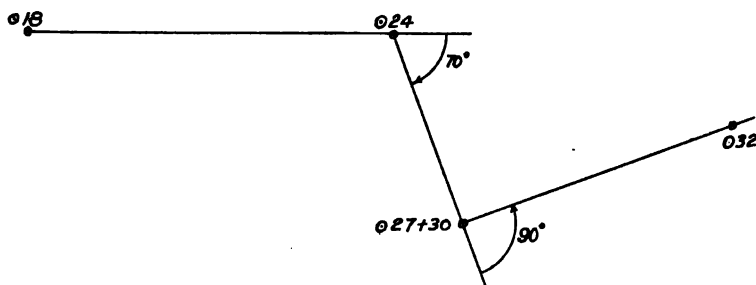


FIGURE 3.

TABLE 1.

Station	Deflection		Bearing	Remarks
	Left	Right		
18				
24		70° 00'	S 20° 00' E	
32	90° 00'		N 70° 00' E	

In places where there are a great many short turns, much time would be consumed in setting up the instrument at every change in direction. Instead of this, several readings may be taken from one position, the distances being

measured around the traverse just as though the instrument were set up at every change in direction.

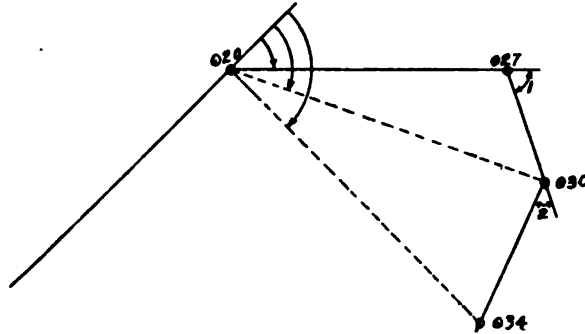


FIGURE 4.

The disadvantage of this method is that the angles 1 and 2 (Fig. 4) are not given directly.

While making transit surveys it is important to take notes of property lines, houses, intersecting roads, stream crossings, direction of the channel, feasibility of relocating stream channel, character of the soil, amount of rock, extent of forest or open ground, etc. It would perhaps be better to have two men go over the line *later* and take full notes of the natural features above mentioned.

The transit party should include at least four persons besides the axemen: transitman, front rodman and chainman, back chainman, and stakeman. The front rodman should display good judgment in selecting tangent intersection points.

LEVELING.

Leveling is done for the purpose of obtaining a profile of the ground. It is the most important feature of the road survey, though often there is no need for it until after the final location survey has been made. The usual method of taking notes for elevations is indicated in the following table.

TABLE 2.

Station	B. S. +	H. I.	Rod	F. S. (-)	Elevation
27 (T. P.)	1.72	106.33	-----	-----	104.61
+ 50	-----	-----	3.1	-----	103.2
28	-----	-----	4.6	-----	101.7
T. P.	0.21	101.32	-----	5.22	101.11
29	-----	-----	2.1	-----	99.2
+ 62	-----	-----	4.2	-----	97.1
T. P.	-----	-----	-----	12.88	88.44
Totals.....	1.93	-----	-----	18.10	-----

on sharp curves. In cases where the center line is along the traveled way of an old road, nails stuck through red cloth (or better through a tin cap used for holding roofing paper) should be driven at the center points and side stakes set at definite distances from the center.

The curves are usually arcs of circles and are laid out by the deflection method.

Δ = Deflection angle in degrees.

D = Degree of curve = Central angle which intercepts chord of 100 feet.

R = Radius of curve in feet.

T = Length of Tangent in feet.

E = External distance in feet.

L = Length of curve in feet.

P.I. = Point of intersection of tangents.

P.C. = Point of curve.

P.T. = Point of tangent.

$$D = \frac{5730}{R}; L = \frac{\Delta}{D} \times 100.$$

EXAMPLE.

Given

P.I. = Sta. 54 + 71.3.

$\Delta = 19^\circ 00'$, E = 15' (approx.).

From tables $T = \frac{958.9}{D}$; $E = \frac{79.7}{D}$

If D = $5^\circ 00'$, E = 15.9'; hence, D = $5^\circ 00'$ is OK.

$$\therefore T = 191.8, L = \frac{19}{5} \times 100 = 380'.$$

P.I. = 54 + 71.3

T = 1 + 91.8

P.C. = 52 + 79.5

L = 3 + 80

P.T. = 56 + 59.5

$$D = 5^\circ, \text{ Deflection} = \frac{5 \times 60}{2 \times 100} = 1.5 \text{ minutes per foot.}$$

Deflection	Station
$0^\circ 31'$	53
$3^\circ 01'$	54
$5^\circ 31'$	55
$8^\circ 01'$	56
$9^\circ 30'$	56 + 59.5

$$9^\circ 30' = \frac{\Delta}{2} \text{ check.}$$

Figure 6 (p. 24) shows a parabolic curve which is laid out as follows: find the middle point of ad at m , then the point half way between m and b ; this gives C the center of the curve. Other points on the curve are found by measuring offsets from the tangents, as is indicated. Note that the offsets from the tangents vary as the *square* of the distance.

GRADE LINE.

The fixing of the grade line upon the profile is one of the most important operations in the design. The most economical grade line is usually that

which most nearly balances the cuts and fills. A convenient method of laying a grade line that will approximate these conditions is as follows: Place a templet (with the shape of the finished road) on each cross-section so that the cuts will just balance the fills (this position is estimated) and note the

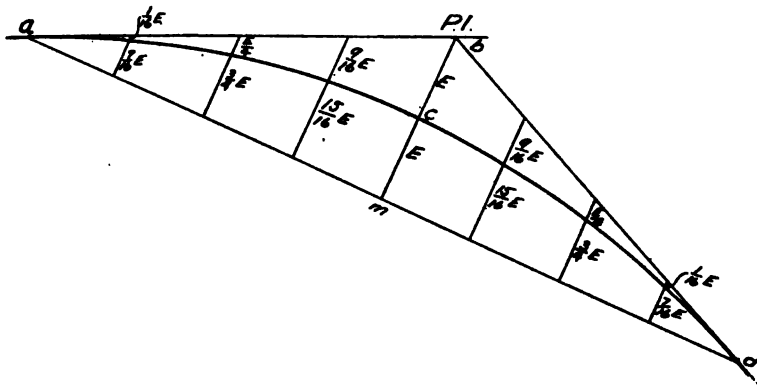


FIGURE 6.

elevation of the center line of the proposed finished road for this position of the templet; mark this elevation on the profile for each section, between certain stations. To connect these points would give the most economical grade line, but this can rarely be done so as to get a smooth grade. The adopted grade is obtained by drawing in a smooth grade line that averages the elevations of these points, as is shown in Fig. 7.

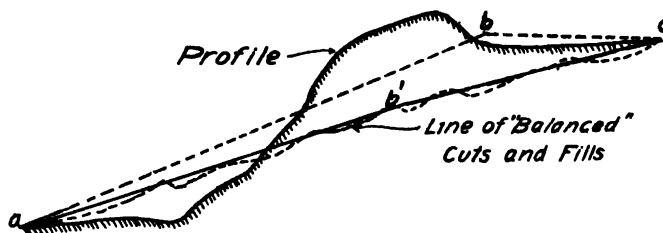


FIGURE 7.

Line *abc* appears to balance cuts and fills, but actually grade line *ab'c* is near the line of "balanced" cuts and fills on account of irregular cross sections.

CROSS SECTIONS.

As soon as the grade line is drawn on the profile, the center cuts and fills are either scaled or computed. The latter method is more accurate and is done as follows (see Table 4):

TABLE 4.

Station	Elevation— Ground	Elevation— Grade	Centre	
			Cut	Fill
12	106.2	106.2	0.0	
13	112.2	110.2	2.0	
14	113.2	114.2		1.0

The shape of the finished road is now drawn on the cross sections at the proper depth above or below center and the areas in cut and fill are determined either by counting squares or using a planimeter.

The volume of earthwork is computed by means of the "average end areas" formula, which is:

$$V \text{ (cubic yds.)} = \frac{A_1 + A_2}{2} \times \frac{L}{27}$$

$$\text{If } L=50', \quad V = (A_1 + A_2) \times \frac{25}{27}$$

where A_1 and A_2 are end areas in square feet, and L =length of section in feet.

The following table shows a good way to record the volume quantities:

TABLE 5.

Station	Centre		Area		Double Area		Distance—Feet	Volume—(Cu. Yds.)	
	Cut	Fill	Cut	Fill	Cut	Fill		Cut	Fill
12	0.0		20.0	16.0					
					220	16	50	204.0	15.0
+50	2.0		200.0						
					364	30	50	337.0	28.0
13	1.0		164.0	30.0					
					164	247	100	304.0	458.0
14		1.4		217.0					

SETTING SLOPE STAKES.

With depth of cut or fill marked on the center stakes, and slope stakes set with the distance out and the elevation above or below center marked on them, and a profile, showing direction of haul, the survey is completed and ready for construction.

In conclusion, an example will be given showing the order of procedure from the beginning to the end in surveying and mapping and estimating the cost of constructing a difficult section of road in Orange County. The various steps were as follows:

- (1) Reconnaissance.
- (2) Preliminary survey with transit.
- (3) Level survey.
- (4) Cross sections.
- (5) Map showing plan profile and cross sections.
- (6) Paper location of road.

- (7) Projected profile obtained from elevations of the off-set points as given by the cross sections, where changes were made.
- (8) Trial grade line and rough estimate of cost.
- (9) Decision as to length of span and width of bridge.
- (10) Center line tangents and curves laid out on the ground.
- (11) Level readings at every stake.
- (12) Cross sections every 50 feet and oftener.
- (13) New profile drawn.
- (14) Cross sections plotted.
- (15) Grade line drawn on profile.
- (16) Shape of road placed on cross sections and areas computed.
- (17) Volumes computed.
- (18) Slope stakes set.
- (19) Bridge abutments and wing walls staked out, and volume of concrete computed.
- (20) Detailed drawings of abutments for contractor.
- (21) Specifications for bridge.
- (22) Position of culvert located, with proper size, length and slope.
- (23) Borrow pit staked out.
- (24) Provision for traffic during process of construction.

Use of the Abney Hand Level.

By T. F. HICKERSON, ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF NORTH CAROLINA.

The Abney hand level is a more useful instrument in road engineering than the ordinary Locke level because with it both a level and incline line



FIGURE 8—Abney Hand Level.

of sight may be established. Its usual form, Fig. 8, consists of a square bronzed sighting tube 5 inches long, a vertical arc having a radius of 1 inch graduated to single degrees with a folding vernier reading to 5 minutes, a scale of grades from 1:1 to 1:10, and a bubble. The price, including a leather pocket case, is about \$13.50.

METHOD OF USE.

Since grades are usually expressed as a per cent, that is, the rise or fall per 100 feet of distance, it is necessary to know the relation between degrees and per cent slopes, which should be remembered as being in the ratio of 4 to 7.

Thus a 7 per cent grade is equivalent to a $7 \times \frac{4}{7} = 4$ degree grade. The fol-

lowing table gives the degrees and minutes corresponding to per cent grades varying from $\frac{1}{2}$ per cent to 10 per cent.

Per cent slope.	Degree slope.	
	Deg.	Min.
$\frac{1}{2}$	0	17
$\frac{3}{4}$	0	26
1	0	34
$1\frac{1}{2}$	0	52
2	1	09
$2\frac{1}{2}$	1	26
3	1	43
$3\frac{1}{2}$	2	00
4	2	17
$4\frac{1}{2}$	2	35
5	2	52
6	3	26
7	4	00
8	4	34
9	5	09
10	5	43

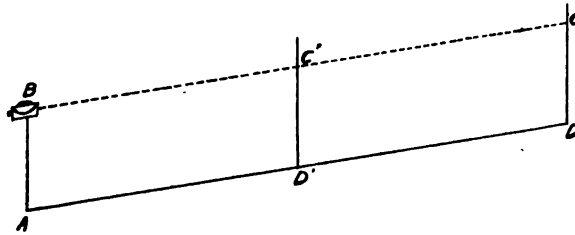


FIGURE 9.

To Locate Points on Grade.—Suppose A, Fig. 9, is a known point on grade and it is required to locate a point D, so that the slope A D shall be on a given per cent grade parallel to the line of sight B C. Set the vernier to read the angle corresponding to the per cent grade and with the instrument held at B in position for sighting, in the hand or on a Jacob staff, then place a rod alongside A B with the bottom on a level with the point A and place a target opposite B on the rod at the "height of instrument" above A. When the "Abney" is swung slightly upwards or downwards until the bubble is in center (this position being shown by means of a prism which throws a picture of the bubble into the field of view), the line of sight B C will be parallel to the desired grade and it is only necessary to have the rod moved about until this line of sight strikes the target in order to locate points at the bottom of the rod so that they will be on grade. Thus, if the target points C and C' are in the line of sight, the points D and D' are on the required grade. It should be noticed that this method of establishing grade points is independent of distance.

To Determine the Amount of an Existing Grade.—Choose two points on the grade. With the instrument held above the first point in position for sighting, place a target on the rod at the "height of instrument," and with the rod held on the second point, move the vernier up or down until the bubble remains in the center and the line of sight strikes the target; then

clamp the scale and read the angle. This gives the grade expressed in degrees which, if multiplied by $\frac{7}{4}$, gives the per cent grade.

There is another way to find the amount of a slope, as in the case of a steep bank. Place the base of the level tube parallel to the surface, move the vernier until the bubble comes in the center, and read the inner scale which gives the slope directly as 1 to 1, 2 to 1, etc.

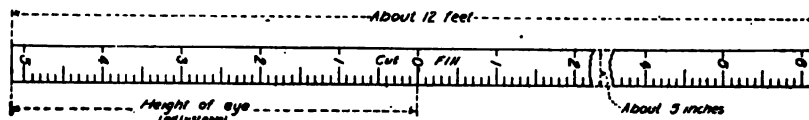


FIGURE 10.

To Determine Cuts or Fills.—A convenient rod for use in connection with the hand level, Fig. 10, is graduated as follows: Mark the height of eye (same as "height of instrument") and label it zero (this would be the approximate height of eye if the rod is made adjustable at the bottom so as to be adaptable for persons of different heights), then lay off distances measured in feet and tenths downwards from the point zero to perhaps five feet or more, depending upon the height of eyes of the person who is to use the hand level, also lay off similarly from the point zero upwards to say six feet, thus giving a rod about 12 feet long. Mark "Fill" just above the zero and "Cut" just below it.

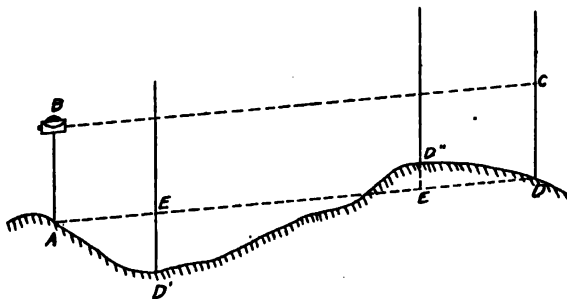


FIGURE 11.

Assume A and D, Fig. 11, to be two points on grade and the instrument set to give a line of sight BC parallel to the grade AD. If the rod is held at D' then the rod reading will be the fill D' E; also if the rod is held at D'' the rod reading will be the cut D'' E.

To Determine Cross Sections.—Suppose A, Fig. 12, is a point on the ground at the center of the proposed road, and it is desired to find the cross profile of the ground on both sides of the point A. With the instrument set to read zero and the zero of the rod at the "height of instrument" (above A) sight on the rod held at all the breaks in the slope of the ground at measured distances from A and the rod readings will give the elevations of the various points above or below A. If the line of sight should run in the ground or be above the top of the rod, move up to the last point or some convenient point and proceed as before, remembering to add to or subtract from the reading for the second position all subsequent readings, in order to refer all elevations to the first position.

A convenient way to keep notes is to express the data in the form of a fraction, the numerator representing the elevation above or below A and the denominator the distance from A. Thus the following notes represent the conditions shown in Fig. 12:

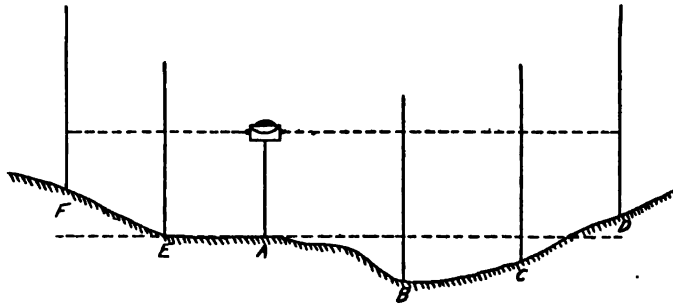


FIGURE 12.

denominator the distance from A. Thus the following notes represent the conditions shown in Fig. 12:

Left.		Right.		
+1.7	0.0	-2.1	-1.0	+1.8
<hr/>		<hr/>		
20	9.0	12	22	30

According to the notes, the point B is 12 feet to the right and 2.1 feet below A; also, the point D is 30 feet to the right and 1.8 feet above A.

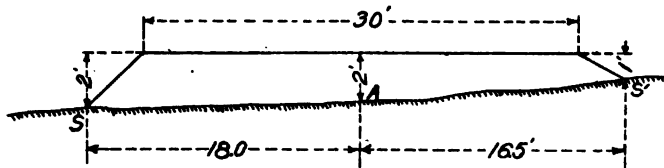


FIGURE 13.

To Set Slope Stakes.—Suppose the center fill at A, Fig. 13, is 2 feet and the road is to be 30 feet wide with banks sloping $1\frac{1}{2}$ horizontally to 1 vertically. It is required to find where the slope of the banks intersects the surface of the ground.

Set the vernier to read zero and clamp it. Use the rod shown in Figure 10. With the instrument at the height of eye above A, sight on the rod held at a distance of at least 15 feet. The rod readings give the elevations above or below A. The method is to guess at the distance and try the elevation, or vice versa. The point S is correct because the rod reading is 0.0 and the distance is $15 + 2 \times \frac{3}{2} = 18.0$ feet. The stake S shows where the fill begins and

it should be labeled thus

}	FILL
	2.0 indicating that it is two feet below and 18.0
	18.0

feet from the center of the finished road. The stake at S' should be labeled

}	FILL
	1.0
	16.5

Differential Leveling.—The "Abney" when set to read zero can be used just as an ordinary level to determine the difference in elevation of two or more

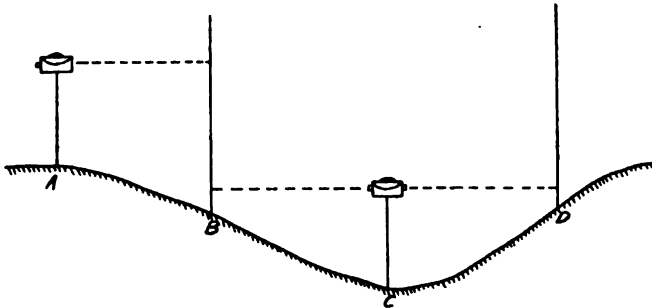


FIGURE 14.

points, in cases where great accuracy is not required. If a rod graduated up and down from the height of eye is used, the notes may be kept as shown in the table.

Station.	+	—
A .....	...	...
B .....	...	5.0
C .....	...	4.2
D	4.0	...
Total	4.0	9.2
Difference = — 5.2		

According to the notes, B is 5 feet below A, C is 4.2 feet below B, and D is 4 feet above C, the difference in elevation between A and D being 5.2; the difference between the sum of the plus and minus readings.

Adjustment.—Set the scale to read zero and raise or lower one end until the bubble remains in the center, then reverse the position of the instrument end for end and if the bubble is out of center the level is not in adjustment. To adjust it, turn the capstan headed screw at the end of the level tube until the bubble comes half way to the center. In order to adjust exactly, several trials are often necessary.

A good way to test the adjustment is to stand on some point A and sight on a target held at the "height of instrument" above another point B and note the angle. Then stand at B and sight on the target held above A and see if the angle is the same (on the other side of zero).

ADAPTABILITY OF THE ABNEY LEVEL TO HIGHWAY LOCATION.

The writer has found the Abney level indispensable in side hill location. It enables one to determine grade points quickly and is a time saver in running preliminary trial lines. As to its accuracy, the readings taken not over 100 feet apart (preferably about every 50 feet) should be within $\frac{1}{2}$ inch of exactness, provided, of course, the instrument is in adjustment and the engineer is careful to keep the "height of instrument" constant. The errors are compensating and for this reason the Abney, in the majority of cases,

will give a preliminary line close enough to be adopted as the final location. The writer has used this level in laying out fully 75 miles of road in hilly and mountainous country.

Very few highway engineers seem to be familiar with the merits of the Abney as compared with the Locke level. It has all the advantages of the Locke and many additional uses.

Economics of Road Construction.

BY W. S. FALLIS, OF HENDERSON, N. C.

The economics of road construction is a subject that is a part of every phase of the road question. Every advantage claimed for the betterment of our roads has its economic side. There is no movement today that commends itself more fully to the support of all the people than the construction of good roads. There is little danger that too much money will ever be spent for this purpose, if there is proper and intelligent consideration given to the financial and construction problems which it involves.

It is not necessary for me to discuss the question of the advantage of good roads throughout the counties of our State. I will, therefore, confine myself to discussion of the proper expenditure of the funds to be used in the construction of roads.

Public roads are built for the use of the people free of cost in the same manner as the public school, the museum or the park; but, though free in a direct way to the user, they are not free in the economic sense because they have involved expense and effort to some one.

What things shall be provided for public use is a question of great public interest, and one of the most difficult problems concerning taxation to be solved by the legislator and the economist.

Economic goods is a term used to describe those things which men want that are not free, but which present the problems of individual or organized industry.

All the constructive efforts of man are of a temporary nature. No sooner has he completed some construction than both nature and man begin to destroy it. The word permanent in its full sense cannot be properly applied to anything made by man.

This is true of roads, and especially true of the road crust or surface. Rain, frost and traffic are the three greatest agencies tending to destroy it. If the road is to retain its value as a road, if the capital invested therein is to remain unimpaired, a sufficient sum of money must be expended yearly to repair the deterioration caused by nature and by the wear of traffic. If this money is not provided and properly expended, the original investment will in time disappear through depreciation.

As Dr. Pratt so earnestly insists, good roads should be good for three hundred and sixty-five days in the year. This, of course, does not mean that the roads shall be so expensively constructed as to present an unvarying surface, a surface as perfect during the worst weather, and under the most adverse conditions as during the period of the year when all roads are at their best; but it means that the construction shall be such that, within reasonable limits, the efficiency of the road shall be maintained throughout the year, due consideration being given to the cost and class of the surfacing. This can be made practicable only where the roads are skillfully and pru-

dently planned, honestly built, carefully financed, and thoroughly and continuously maintained.

It is not my purpose to go fully into that phase of road economy which would involve a discussion of the subject of raising funds for the work; but I must voice an earnest warning in regard to the expenditure of a certain class of road funds.

It is a common thing for our counties and cities to issue bonds, for extended terms, for the purpose of road and street improvement. In many cases this is a proper way for them to procure funds for much needed improvements; but it is all too common an occurrence for the money thus raised to be spent in work of a temporary nature. In many cases, where the money is borrowed for, say thirty or forty years, the purpose for which the bulk of it has been spent has entirely disappeared in perhaps ten years. If recklessness of this nature is persisted in (and no one can deny that it is now very common), a reaction, more or less serious, in the progress of road building is sure to result. The remedy for this is not to prohibit the issue of bonds for either long or short periods of time, where other funds of sufficient amount are not available; but to intelligently and prudently plan the expenditure of such funds, so that a large measure of value may remain in the work at the expiration of the time for which the bonds were issued.

The road surface, in many of its more or less expensive forms, is of such temporary nature that it is extremely wasteful, to say the least, for counties whose present wealth is such that funds for road improvement are limited, when compared with the amount of mileage and the topographic and other natural difficulties, to expend large sums on surfacing their roads or in ill-considered endeavors to secure a large mileage of poorly constructed roads.

When money for the initial work of road improvement in a county is to be expended, no matter how the money has been procured, prudence demands that a careful investigation by competent, trained and experienced men shall be made and definite plans determined upon before any work is begun. This is especially true when money raised from long term bonds is to be used.

A definite plan is needed in order, among other reasons, to distribute as equally as possible the benefits of the improvement to the tax payers; to eliminate as far as practicable changes in value to the individual property owner, by following as nearly as may be the general course of existing roads; to determine the kind of surfacing, its probable cost, and the probable cost of maintenance; to consider in every phase the future of the system of roads; and to spend the bulk of the money in the more permanent parts of the road. The location, the grade and the drainage of a road are the more permanent parts and the only parts that can reasonably be expected to contain any part of the original investment at the time the bonds of a thirty or forty year issue are due.

I, therefore, earnestly urge that the larger part of the funds now being spent on the roads throughout the state be used for laying a foundation upon which, in the future, improved surfaces can be built.

SOME FACTORS IN THE ACTUAL WORK OF CONSTRUCTION.

Economy in the actual construction of roads can be assured only when the laws are such as to guarantee to the local or county administration sufficient power to handle to the best advantage the various problems they will have to meet.

The executive body or county board itself should be free from politics and political connections or ambitions, men of unselfish motives and high purposes. This condition in every aspect is, perhaps, unusual but not impossible of attainment, as my own experience has demonstrated.

An engineer should be employed who is competent and experienced and who has a high conception of his profession. Ample power should be given him to decide and enforce all questions that are entirely professional in their nature, and his advice should receive full consideration by the commission where the matter is both professional and administrative. To illustrate: It should be the function of the Road Commission to plan the order in which the roads should be built; and to name the two or more points between which a road is to be built. It is the right of the engineer to determine all matters relating to the location of the road between these points. He is held responsible for this by the profession generally; by the people of the county especially; by the Road Commission directly; and, therefore, this is his right as a matter of simple justice. Should the question be one of the class or quality of construction to be used at a given place, or in the general work, the office of the engineer should be advisory in nature just as a lawyer advises his client.

The question of obtaining right-of-way for road purposes is vital to all the tax payers, and is an avenue through which a considerable percentage of the county road funds may disappear. This accentuates the necessity of broad justice in handling it rather than a too close observance of the written law.

Experience has taught us that a good road increases the value of land, according to the distance from and the accessibility to it. The value of the land abutting on the road is, of course, increased much more than that of land lying farther away. It is seldom possible to injure a farm by building a good road through it, and the place where actual damage can be done is very exceptional.

Every tax payer in the county shares, according to his property, the burden of road improvement. He should, therefore, receive his due measure of benefit from the money expended thereon.

In estimating from my experience this item, the cost of right of way for road construction, will, if neglected or allowed to be handled according to the average county law, amount to something like two hundred dollars per mile of road wherever relocation, or even partial relocation, is required. This money was originally appropriated by the people for the purpose of building roads, and every man paying a road tax has the right to know that his money has been used in building roads. Every dollar spent to pay "A" for right of way gives "A" a dollar and a good road that enhances the value of his farm more than that of the farm of his neighbor which does not touch the road, while it takes from "B," who may be unfortunate enough to live just beyond, a dollar and a good road. The dollar paid to "A" should in all justice go into a road for "B." My experience has proven conclusively that an equitable method of adjustment can be arranged that will not bring undue friction to the Road Commission nor work harm to any one.

Experience and care are necessary in organizing for work if economy in the work is to be assured. Every effort should be made to keep the overhead or administrative expense as low as possible. When little time and nominal responsibility is required of a board member, the expense for his service

should be nominal. Members of the County Road Commission, if paid at all, should be paid for the actual time given to the work. I would suggest that the amount should not be designated until the organization has been completed and work well begun, for the reason that the bulk of the work required of or necessary to be done by members of the commission is several times larger at the commencement of the work than later on. If designated during the time of organization, it will frequently result in larger allowances for the service of executive members than they themselves would consider equitable and just at a later time.

The superintendent and foreman should be men of experience in the class of work they are expected to do, well qualified in every way for handling the machinery, equipment and work. Many mistakes are being made in the selection of these men. They constitute the most important part in the organization, so far as economy in getting results is concerned. Great care and experienced judgment should be used in selecting just the right men.

A good foreman for this class of work should have the qualifications usually needed by men placed in authority over labor. He should be sober, industrious, sufficiently educated, and a man of good judgment in handling labor; but he should be especially experienced in handling earth excavation by the use of the kind of machinery provided; should know when he is getting results; and should understand thoroughly the proper amount of work to be done by his mules. This last and special experience is vital, for on it depends, more than on any other one thing, the cost of the work.

In an organization requiring a superintendent, and when several outfits are worked, the service of a superintendent as a general executive is absolutely essential for the systematic and, therefore, economical conduct of the work. His duties are so obvious and at the same time so numerous that I shall not go into details, but simply say that his chief duty is to keep the various outfits in condition to work at their highest efficiency.

It is my opinion, based on my own experience in this class of work, that for the construction of sand-clay or topsoil roads, or for any class of road work where the bulk of the expense will be in the excavation and grading, the most economical method is by county organization in preference to contract work. This is not the result of any prejudice or hasty judgment in the matter, but the result of careful investigation. I have been, in common with the majority of engineers, inclined to favor the contract method in many classes of work. The plan of contracting is without a doubt the cheapest in many classes of construction work. In cases where the amount of work in grading is so small that the cost of organization and proper outfit would be excessive in comparison, or where the class or kind of work calls for an expensive outfit that will be useless capital in the hands of the county when the work is completed, I would unquestionably favor contract work.

In support of the idea favoring county organization I would state that the outfit required for road construction when sand-clay or topsoil work is to be done, with the exception of the mules required, may, after about two years' work, be considered as very nearly or quite worn out when the work is completed, and its value almost entirely incorporated in the work. The depreciation in the value of the mules can, very conservatively, be estimated at ten per cent per annum. To demonstrate this I will refer to the work in Franklin Township, Franklin County. The depreciation in the value of the mules,

after nearly four years of service, amounted to nine per cent per annum. The cost of each team per day was 20.6 cents of the capital invested therein. The cost per cubic yard of the work, after a careful calculation which included the total cost of all tools and machinery in the expense involved, was not quite fifteen cents. The depreciation of the mules used in Franklinton Township was perhaps greater than would ordinarily be the case, as they were used for a longer period than mules should be used. The most economical method of handling this item is to purchase young mules five or six years old and of not less than eleven hundred pounds weight, work them for two or two and one-half years, and sell them before their annual depreciation becomes great on account of their age.

To refer again to the importance of the qualifications of foremen, I wish to quote some figures that came within my experience.

In one of the counties in which I had charge of the work, I used six outfits of equal equipment and on like work. Two of the foremen were men experienced in the class of work they were doing. The other four, while energetic, hard working men, had never handled that kind of work. At the end of three months I made an investigation of the results (this investigation should have been made at the close of the first month, but the cost accounting was in such shape that I could not get at it) and found that the two experienced men were handling their work close to sixteen cents per cubic yard, while the other four were averaging around twenty-eight cents. In other words, considering the total yardage handled by the different outfits, the two experienced men had in each case given in value about \$1,300 more in work, although I was at that time paying all six of these men the same salary.

I cannot close this discussion without saying something in regard to the keeping of cost accounts, and their importance in holding down the cost of work.

If, in the above reference to the comparative value of the foremen, I had been able to get at the *results* of my endeavor to keep track of the costs, I would have saved some hundreds of dollars in that first three months; and this, while very important, is only one of the leaks in construction work that a proper cost accounting will expose.

The method that is considered sufficient as a rule, simply seeing that the men have worked the number of hours for which they are paid and that the goods were received for which the bills are paid, is an utterly insufficient and worthless handling of a valuable auxiliary for the economical conduct of the work.

I would add, in closing, that a constant watchfulness over and understanding of all the elements that go into road construction must be constantly maintained by the responsible head of the organization, if the best and most economical results are to be obtained.

Sandclay and Topsoil Roads the Economic Roads for North Carolina.

BY JOSEPH HYDE PRATT.

In many sections of North Carolina the communities have not sufficient funds for road purposes to enable them to construct the more expensive roads such as, bituminous macadam, bitulithic, vitrified brick, concrete, or even water-bound macadam. There are roads, however, that come within the

means of all communities, and these are the sand-clay and topsoil. Unless traffic is very severe these roads will give satisfactory service, and, whenever the traffic becomes so heavy that a harder surface is necessary, there will be a splendid foundation upon which to build the new surface road. It will also mean that the community has acquired sufficient wealth to enable it to build harder surfaced roads. Where counties have sufficient funds to enable them to build macadam roads the North Carolina Geological and Economic Survey advises that such counties build the bituminous macadam roads in the environment of their cities. Where the traffic is less heavy, supplement this road with the sand-clay or topsoil road leading to the boundaries of the county.

In discussing a sand-clay, topsoil or gravel road we must bear in mind that we have under consideration a specially surfaced road, just as distinct a road as the macadam, cement or vitrified brick. The same care and preparations should be employed in grading and preparing the roadbed for these surfacing materials as when the other, harder materials are to be used. The present paper deals with the surfacing of the road after the grade has been completed. The portion of the road that is to be surfaced with sand-clay, topsoil or gravel should be left nearly flat and sufficiently lower than the shoulders so that when the surfacing is completed, the road will have the right slope from the center to the ditches.

There is a tendency in grading the roadbed to leave that portion which is to be surfaced too high, with the result that either the finished road has altogether too steep a crown or the surfacing material is not thick enough. The thickness required will depend upon the character of the subsoil.

In certain localities where there are both clay and sand soils, the ordinary country road is found to contain sections that are composed principally of clay, others of sand, and occasionally a section is observed that is hard all the time. This, upon investigation, will be found to be composed not of clay or sand but a mixture of these two. In such regions it is not uncommon to find soils that are a mixture of sand and clay and in such proportions that when used for surfacing a road they make a hard surface like the natural surface just referred to. Such material is known as topsoil, and the road as a "topsoil road." When, however, it is necessary to mix the two artificially it is called a sand-clay road.

I first want to take up the sand-clay road: A recent article in the *Greensboro Daily News* gives the following:

"Of the various stretches of sand-clay about Greensboro, some are now in good condition, some are very bad and some are neither the one nor the other. All have gone through the same weather, and the differing conditions are in evidence on stretches of road that have apparently had about the same amount and kind of traffic. Why is it that some parts are still good and others are horrid? Answer that, and you have found all the essential secrets of substantial road building and maintenance in this part of Guilford County."

This is undoubtedly true and it will still be found that one section of the road was constructed in the right way and with the right kind of materials.

CONSTRUCTION OF THE SAND-CLAY ROAD.

Quality of the Sand and the Clay.

Before beginning the construction of a sand-clay road, the sand and clay in the vicinity of the road should be examined to ascertain whether they have the right properties necessary to build a first-class sand-clay road. The best sand or gravel to use is that which has a sharp cutting edge and it should not be in too fine grains. A clean, sharp grit, such as is desired in making mortar is the quality of sand that is wanted. The best results are obtained, however, when the grains of sand are coarser than those used in making mortar. While any clean sand will make a sand-clay road, the sharper the grit the better the resulting road. The characteristics which are most desirable in the clay are plasticity and the ability to slake well when it first becomes wet. A clay is called plastic when it becomes sticky or dough-like when mixed with a certain amount of water, so that it can be molded or pressed into various shapes which it will retain even after it has been dried. If a lump of such clay is put in water, it will usually retain its form for a long time. There are other clays, however, which will immediately fall to pieces when placed in water as a lump of quick-lime will do under similar conditions. This is due to the very rapid absorption of water into the porous construction of the clay. It can readily be seen that this characteristic is an important one when considering the material to be used in a sand-clay road. There is still another physical characteristic of clay which is to be considered from the standpoint of the road builder. Some clays shrink when dried, which is shown by the cracking and breaking out of their surfaces. This shrinkage is the measure of their expansion and expansion makes a sand-clay composition unstable. Shrinkage would do no harm if the clay would stay in this condition, but it does not. When water, removed by evaporation, is restored to the sand-clay mixture, its entrance is accompanied by a simultaneous expansion which causes the grains of sand to become separated. This property can not be overcome, for it is inherent in the clay; but we can, in some measure, modify this fact by using less clay in the composition. This, however, will weaken the road and cause it to break up in dry weather. Avoid such clays if possible.

One good test for a clay is to wet the thumb and place it against the clay, and if it sticks to the thumb it is of the right quality for making a sand-clay road. If, on the other hand, it does not stick to the thumb, we are safe in assuming that this particular clay will not make a good binder. In general, select the stickiest clay and the sharpest sand available.

The proportion of sand and clay in the best sand-clay road should be such that there is just a sufficient amount of clay, and no more, to fill the voids between the grains of sand when these grains are touching each other. The clay is the binder that is to hold the grains of sand in place and there should not be any more than is sufficient for this purpose. If too large a proportion of clay is used, the grains of sand are prevented from touching each other and are able to move about each other in the mass of clay so that the resistance of the mass to the wearing effect of traffic is practically no more than if the road was composed simply of clay. Water is also able to act upon the mass of clay and the road becomes sticky and muddy. If there is too small a proportion of clay used, the grains of sand are not cemented tightly together and the road disintegrates very quickly under traffic and rain.

The exact proportions of sand and clay for making the best sand-clay road can not be stated, as the proportions vary with the character of the sand, according to its sharpness, percentage of foreign material and size of grains. Approximately there is in a sand-clay road about eighty per cent sand and twenty per cent clay. One simple means of determining the theoretical amount of pure clay that should be added to any sand that is to be used in the construction of a sand-clay road is to fill a glass tumbler brimfull with the sand that is to be used and then fill a similar tumbler with water; pour the water carefully onto the sand until the water comes flush with the surface, which will mean that all the voids between the grains of sand are now filled with water. The amount of water that has been poured into the tumbler containing the sand will represent the proportion by volume of clay that it is necessary to add to that particular sand to fill all the voids with clay.

A suitable clay may be found in the subsoil of the road, to which sand must be added; or the sand required may be the subsoil to which clay must be added; or it may be necessary to obtain away from the road both constituents for the sand-clay surfacing.

Method of Mixing Sand and Clay.

Having determined the source of supply of the best materials for making a sand-clay road, the next question is the mixing of the materials, and this varies with the character of the subsoil, i. e., whether this is a sand upon which clay is to be added or clay upon which sand is to be added, or whether both sand and clay have to be hauled onto the road. It will be found that it is much easier to make a sand-clay road where the subsoil is a clay.

Clay Subsoil.—The road should be properly located and graded. There are two ways of preparing the surface of the road before the surfacing material is added. One which has been found very satisfactory is shaping road from the ditches to within one and a half to two feet of that portion of the road that is to be sand-clayed with the right slope that is desired for the finished road, and then shaping the road from that point to the center with a very slight grade, so that when the surfacing material is added and set it will give the right slope from the center to the ditches. The sand-clay mixture will feather-edge to that portion of the road that has already been given the right slope. Another method is to leave that portion of the road that is to be surfaced about two to three inches lower than what is desired when the road is completed. This will give a shoulder on each side. When this is finished the portion of the road that is to be sand-clayed is within nine to sixteen feet in the center. The portion of the road that is to have the sand-clay surface, either nine or sixteen feet in the center, should when perfectly dry be plowed to a depth of three inches and thoroughly harrowed with a cut-away (disc) harrow. The sand should then be spread over the surface to a depth of four inches and thoroughly harrowed in, and then four more inches of sand spread over the surface, and again thoroughly harrowed. After this mixing of the sand and clay is completed the road should be dragged. A slight crust will form but with the first rain this will break through for the mixed sand and clay underneath have not cemented but are loose particles. After the first heavy rain the road should again be harrowed and then dragged into shape so as to give it the proper crown, and it will

then become a firm, hard-surfaced road. If a roller is convenient this may be used to some advantage.

Very often this second mixing is left entirely to teams. In the end a satisfactory road is obtained, but it takes a much longer time.

If the sand-clay road is constructed as outlined above and good clean sharp sand is used on a plastic clay, a first-class sand-clay road will be the result.

In too many instances in constructing a sand-clay road the sand has simply been spread over the clay and it has been left for teams to mix it in with the clay. This takes a long time and very often there is not a thorough mixing of the two materials, so that the resultant road is not always uniform in its construction and does not give as good satisfaction as when constructed by the method described above.

If the sand is added to the clay road when it is wet, the harrowing can all be done at one time, and, when shaped up and dried out, it becomes a hard-surfaced road. The main objections to making the sand-clay road in this way are that unless the clay road is extremely muddy and wet the harrowing of the sand into the clay causes considerable of the clay to get into round balls, which are not broken up by the harrowing; and that is not as even a mixing of the sand and clay as when they are thoroughly mixed dry and then harrowed later when they are wet.

Sand Subsoil.—If in making the sand-clay road we start with a sand subsoil and have to add clay to this, the method of procedure is somewhat different from the case outlined above. The sandy roadbed should be left flat and then a layer of clay spread over it to a thickness of 3 to 7 inches, according to the quality of the clay and the amount of sand which it contains. If it is a very pure plastic clay, it will take a much smaller amount than if it is a very lean or sandy clay. There should then be spread over the clay a layer of clean sand and the road thoroughly harrowed. After this has been accomplished, the road should be brought back into shape and then after a heavy rain again harrowed and shaped up. There is usually a tendency to get too much clay in making a sand-clay road when the sand is the subsoil. If the clay that has been used is a very plastic clay, there is going to be considerable tendency for it to ball and cake so that a plow can very often be used to advantage in breaking up the lumps. If, however, the mixing is made when everything is perfectly dry, a pretty complete mixture can be obtained by harrowing unless the clay has been dug when it was wet.

One noticeable difference in making a sand-clay road with a sand subsoil instead of a clay subsoil is that the number of loads of clay that it is necessary to haul is much less than the number of loads of sand.

The cost, however, of obtaining a thorough mixture of clay on sand is much greater than with sand on clay.

As stated above, it is impossible to determine exactly the proportions of sand and clay to use either in making the sand-clay road on a clay subsoil or on a sand subsoil; and, therefore, as the road dries out and sets it should have careful attention after it is completed to determine whether it is necessary to add any more sand or clay. If there is too much clay there will be a tendency for the surface of the road to get sticky or muddy in wet weather and for the clay to ball and cake, and if this is the case a thin layer of sand should be spread over the surface. On the other hand, if the surface of the road loosens in dry weather, it is an indication that the clay that has

been used is not a good quality of clay and does not have sufficient binding power. More clay should be added and worked into the road.

Drainage is one of the most essential features in road construction and it is very true in connection with the construction of the sand-clay road that it shall have good drainage. Where the subsoil is a sandy one it usually affords a pretty good natural drainage; and where there is considerable depth to the sand, usually the crown of the road is all the drainage that has to be done. It is necessary, however, in all cases that the water be taken out of the side ditches just as rapidly as possible. Where the subsoil is a clay, very careful attention must be given to the question of getting rid of the surface water. Also in clearing the right of way for the road, all stumps, logs, and other vegetable matter should be taken out of the roadbed for, if not, after the sand-clay mixture has been made, wherever vegetable matter exists it will as it decomposes, make moisture and loosen and soften the sand-clay construction. Proper drainage is, therefore, very essential in the construction of the sand-clay road, and it should be maintained at all times.

Dirt and Loam Base.—Where the roadbed is composed of dirt and loam, it will be necessary to haul both the sand and clay. The surface should be about the same shape as that where sand is added to a clay base, except a little lower between the shoulders, for practically all the material added will build up the crown of the road, but very little becoming incorporated with the original surface.

Add 4" of sand to the road, then 2½ to 3" of clay, harrow thoroughly, and then add 4" more of sand and harrow thoroughly. Best results will be obtained if the materials are thoroughly dry when mixed, filling, harrowing, and shaping of road the same as when sand is added to clay base.

Quantity of Sand or Clay.

The following figures regarding the quantity of clay necessary to add to a sand subsoil to make the sand-clay road, and the amount of sand necessary to add to a clay subsoil will be of interest.

If the roadbed is nine feet wide on a sandy subsoil and the clay is added to a depth of 4 inches, it would require 570 cubic yards of clay to cover a mile of road. For a sixteen-foot road it would require 1,050 cubic yards of clay. If the clay is a first-class plastic clay free from sand and only three inches of clay were needed, this would require 441 cubic yards for a mile of nine-foot road, and 787 cubic yards for a mile of sixteen-foot road.

If the roadbed has a clay subsoil and sand is added to a total depth of eight inches, it would require 1,173 cubic yards per mile for a nine-foot road, and 2,085 cubic yards for a mile of sixteen-foot road.

The actual cost of the construction of the sand-clay road for any section can readily be determined by knowing the distance the sand or the clay has to be hauled and the cost of labor and teams per day.

SUMMARY.

Clay Base.

1. Have the top of the clay graded smooth and about four or five inches lower than it will be when finished.
2. Plow and harrow the top for the width the sand is to be put on, leaving loose but smooth, with no big lumps.

3. Spread an even layer of sand about four inches deep over the top and plow and harrow.

4. Spread four more inches of sand over the top and harrow and drag thoroughly.

5. Use clean coarse sand, even if it has to be hauled some distance.

6. When possible, harrow just after a rain.

Sand Base.

1. Smooth the sand road, leaving it perfectly flat.

2. Spread the clay the desired width and from three to four inches thick.

3. If the sand base is clean sand, drag it up on the clay for a thickness of four inches and plow, harrow and drag thoroughly, preferably after a rain.

4. If the sand base contains loam, haul clean sand from a pit.

5. Use natural sand-clay mixture in preference to pure clay.

As I stated at the beginning of this paper: Occasionally a natural mixture of sand and clay has been found in the right proportion and of the right quality to make a hard surfaced road. Where such materials have been found in the fields adjoining the highway and have been used in surfacing it, the mixture has been called "topsoil dressing" and the resultant road a "topsoil" road. In reality, however, it is a sand-clay road and we have simply used a mixture of the sand and clay which nature has provided.

In using this natural mixture the surface of the road should be prepared the same as for a road where both sand and clay are added.

This natural mixture of sand and clay should be added to a depth of 8 to 12", according to the character of the subsoil, a sandy subsoil requiring the greater amount. After the material has been spread it should, if possible, be harrowed when wet and then dragged. If a spreader has not been used, or if the material has not been raked, a road machine will quickly cut out the greater part of the unevenness, and the drag will finish it.

Occasionally a condition is found where there is plenty of good clay but no sand. In some such cases it has been noticed that there is considerable white quartz, or sometimes trap rock in the vicinity. I believe then it is a feasible proposition to make our own sand by crushing the quartz or trap rock and construct a sand-clay road. In such a case I would use material that would pass a 3-8" screen and catch on a 1-8" screen.

This will increase the cost of the sand-clay road, and its economical use will depend upon the total cost of the road as compared with other surfacing materials.

Dust Prevention and Binders.

The life of the sand-clay road can be increased by using certain commercial binders.

It is believed that glutrin and certain of the light asphaltic and other oils can be used on the sand-clay roads not only to prevent dust but also to harden the surface and make it more resistant to water.

Maintenance.

While the maintenance of a sand-clay and topsoil road is very easy and can be done at low cost, yet it must be constant and systematic. The road drag of the split-log type is the most efficient machine. This should be used just after a rain, as the road is beginning to dry out. The principle of the drag is not to cut and move much material but to push and smear material

and pat it down in the small depression that may have formed on the surface of the road.

Natural Sandclays in North Carolina Piedmont Belt.

By JOHN E. SMITH, INSTRUCTOR IN GEOLOGY, UNIVERSITY OF NORTH CAROLINA.

To a limited extent natural sand clays, though in many places undiscovered, exist in nearly every county in the Piedmont. Their occurrence is quite general in the areas of granite rocks which embrace the following counties in North Carolina: Mecklenburg, Gaston, Cabarrus, Rowan, eastern and southern parts of Iredell and Lincoln, Davidson, Guilford, Alamance, Caswell, Granville, Vance, Warren, Franklin and Wake.

This material is derived from igneous and metamorphic rocks by disintegration and decomposition. Probably the most common sand-clays result from the breaking down of granite which consists of quartz and orthoclase feldspar with or without smaller quantities of several other minerals. As the granite weathers, the quartz becomes sand and quartz pebbles and the other minerals change to clay. A "decomposed granite" is therefore a typical one of the natural sand-clays of the Piedmont and will be taken in this paper for consideration.

A GENERALIZED SECTION.

	<i>Thickness</i>
1. Soil at surface, red to gray and black (humus)	1 to 2 ft.
2. Subsoil, fine, somewhat compact, red to yellow clay	3 to 10 "
3. Clay, coarse and lumpy, rotted rock with some sand	5 to 20 "
4. "Gravel," pebbles of quartz and orthoclase, with sand and clay.	10 to 20 "
5. Fragmental rock, partly decomposed angular fragments up to 2 or 3 inches in diameter	5 to 10 "
6. Granite, rock masses, angular and broken, much coarser and less decayed than those in No. 5	5 to 10 "
7. Solid granite, "bedrock," "country rock."	

Since clay is predominant near the surface, shown in the generalized section, decreasing somewhat uniformly as the depth increases, and since the relative amount of sand and rock increases gradually with the depth, there is a level somewhere in the pit at which these materials occur in any desired proportion. The right quantitative relation of the two constituents used in building natural sand-clay roads is found in No. 4 of the section above.

The figures of the first column represent thickness in the eastern Piedmont, where the depth of No. 4 is from 10 to 20 feet; those of the second column apply to the western counties where this layer is sometimes forty feet or more below the surface. The "gravel" of No. 4 may be found at the surface on low hills between the branches of streams or along the sides of the valleys near the tops of the hills or slopes. Prospecting in such places as these will generally result favorably if the underlying rock produces a good sand-clay.

Fortunately these are desirable locations for they insure perfect drainage in the pit, ample facility for disposition of the overburden, and are near the upland peneplain on which the principal roads are constructed. Productive locations can generally be found in pasture lands or woodlands and it is therefore unnecessary to open a pit in a field or to remove gravelly soils from cultivated areas.

Volumetric Tests.

In the University of North Carolina the method used by classes in Geology 8A, road materials, in determining the relative proportions of the constituents in natural sand-clays is essentially as follows and some of the results are given below:

1. Measure out about 1,000 cc of the material in a conical graduate. Tap the glass with the hand for a few minutes and record the amount.
2. Grind the measured material as fine as possible with mortar and pestle. (Road traffic will provide more wear than this.)
3. Wash the "gravel" thoroughly in shallow pans and allow it to dry. Keep the water containing the clay, allow it to settle (or flocculate it), decant, measure, and report the reading.
4. Put the dry washed sand in the flaring graduate, tap firmly with the hand, and pour from a measured quantity of water into the vessel, permitting it to run slowly down the glass on one side until the voids are filled. Label the material and record the amount of water used.
5. Compute the percentage of voids, the amount of excess clay, and the additional percentage of stream sand necessary to utilize the excess clay.
6. Tabulate results as follows:

TABLE 6.

Number of Test	Original Volume—cc.	Clay Washed Out—cc.	Sand Remaining—cc.	Water Filling Voids—cc.	Volume of Voids—%	Excess Clay—cc.	Stream Sand Necessary—%
4	1,200	330	800	225	31.9	75	17.3
10	2,100	760	1,220	452	37.0	308	39.6
11	800	263	650	212	32.6	51	17.7
12	1,000	125	805	243	30.2	0	0

These samples were taken from a pit at Chapel Hill; No. 10 from a high elevation in it. No. 12 was dug from the floor at the lowest level in the pit.

STREAM SANDS.

When a stream is cutting valleys in an area like the Piedmont, the sand and clay are washed away and separated by the water, the former usually being deposited in bars along the lower course of the stream. These are known as stream sands and are frequently used in road building. The results of several tests to determine the percentage of voids in stream sands are given below:

TABLE 7.

Number of Test	Volume of Sand— cc.	Water Filling Voids— cc.	Volume of Voids— %
2	1,000	366	36.6
4	1,000	320	32.0
9	1,000	386	38.6
10	750	275	36.6

No. 2 is sand from Bolin's Creek. No. 4 is a true gravel, being that which was retained on a screen having square meshes five-sixteenths of an inch each way. No. 9 is Morgan's Creek sand. No. 10 is from the same locality as No. 9, but was closely compacted in the graduate. All of the estimates were made with moderately dry sand.

PRINCIPLE AND ITS APPLICATION.

"The proportion of sand and clay in the best sand-clay road should be such that there is just a sufficient amount of clay, and no more, to fill the voids between the grains of sand when these grains are touching each other. The clay is the binder that is to hold the grains of sand in place, and there should not be any more than is sufficient for this purpose."

From the results given in the above tables, it is seen that in many instances the amount of clay present in the natural sand-clay is too large. This last column in table No. 1, gives as a percentage the number of loads of stream sand to be mixed on the road with 100 loads of the natural sand-clay. In No. 4, of Table 1, for example, the amount of stream sand (voids, 36 per cent) necessary for use with 75 cc of clay is 208.3 cc., or 17.3 per cent of 1,200.

Test of samples of the material taken from various elevations in the pit should be made to determine the exact level at which the correct percentages of sand and clay occur. Loads removed from each level in the pit higher than this, contain a larger proportion of clay and should be put together on a separate part of the road. The material from each level in the pit should be tested and should have the proper amount of clean sand mixed with it on the road to use as a binder the excess clay it contains.

A careful examination of the washed sand and pebbles shows that nearly one-third of it is feldspar (orthoclase) which will, in time, decay, forming clay. This will appear as mud when the road is wet and its occurrence should be the signal to apply additional sand, if a hard surface is to be maintained on the road.

The Department of Geology of the University will make a limited number of tests of sands and natural sand-clays from various parts of the State, if samples are sent by parcel post. They should be accompanied by full information as to source of material, its location and depth in the pit, ownership, etc.

SUMMARY AND CONCLUSIONS.

Natural sand-clays occur in most parts of the Piedmont belt in North Carolina. Careful search on the valley slopes in uncultivated areas will





A.—Dirt road that could be improved 100 per cent by use of split-log drag.



B.—Road with steep grades (average 10 per cent). Travel made more difficult by uneven surface of road; large stones project above road.

usually find locations where pits may be opened. "Gravel" and coarse sand have a smaller percentage of voids than finer sand. When more clay is present than necessary, enough clean sand should be added to use all of it, and a better grade of material can be found at a lower level in the pit.

Dirt Roads.

BY JOSEPH HYDE PRATT.

When we stop to consider the number of miles of road in any county and compare this number with the small number representing the miles of specially surfaced road, we can readily see that it will be a great many years—perhaps, generations—before all, or even half, the public roads are surfaced with macadam or sand-clay. For this reason it is very important that we should give very careful consideration and thought to the construction and maintenance of the dirt road.

When properly constructed, the dirt road can be kept in good condition throughout nearly the whole year, except, perhaps, during periods of severe freezes and thaws. At the present time we have very few earth roads but what can be improved, and usually the question of the improvement is not a very difficult one to solve. (Plate II, A and B.)

The old idea that anybody can build a dirt road is fast losing ground, and our people are beginning to realize that road construction, even of dirt roads, requires the services of men who have been trained in this line of work. As careful thought should be given to the construction of dirt roads as is given to the hard-surfaced roads; and in those counties which rely entirely on the labor tax for the construction of their public roads a great advance can be made if this labor tax is utilized under the supervision of an experienced road engineer.

The location of any public road is the only permanent portion of the road; therefore, great care should be taken that when the road is once constructed there should be no question whatever regarding its relocation. In locating a road it should be done so as to permit of an easy grade—none over $4\frac{1}{2}$ per cent—and should be constructed so that it will readily shed the rainfall. How often we see a road going up a hill and down the other side, when, by building around the side of the hill, it could have been kept at an even grade, reaching the identical point within the same distance, or but little greater.

If, in grading a road, we have any grades over $4\frac{1}{2}$ per cent, it will be necessary to construct across the surface of the road a V-shaped surface ditch to turn the water off the surface of the road, for if this is not done the water will, with the grade over $4\frac{1}{2}$ per cent, have momentum enough to seriously gully the surface of the road. No matter how carefully these V-shaped ditches across the surface of a road are constructed, they are very inconvenient to travel, are hard on the wagons, and should be avoided wherever possible. They can be avoided if the grade is kept below $4\frac{1}{2}$ per cent. In Plate II B is illustrated a steep grade on a road in Davidson County, N. C., which could readily be eliminated by relocation of the road. The surface of the road is uneven, and large rocks are projecting above the surface. "Thank-you-mams" have been made across the road to turn the water off the surface of the road, which add a great deal to the discomfort of travel over this road.

The dirt road is more susceptible to damage by water than, of course, any of the specially surfaced roads; therefore great care should be taken

to work out an efficient system of drainage for the road. Water must be kept away from the road, and the rain which falls on it must be permitted to run off as rapidly as possible, and by a very easy grade. It must not only be taken off the surface of the road as rapidly as possible, but, also, out of the side ditches. Care should be taken that these side ditches are not too steep, and that every opportunity is seized for turning the water out of the ditches into the adjoining fields.

Many of our country roads are bad because in their construction no arrangement was made for taking care of the water, and thus they are very muddy and filled with ruts and holes. Instead of the middle of the road being higher than the edges, so that the water can readily run off on each side, many of them are flat, or even concave, with the center of the road the lowest point. If the road has been constructed so that it is well crowned, with the slope about 1 in 20 from the center of the road to the side ditches, and these ditches have been graded so as to readily take care of the water, and yet not steep enough to cause them to cut deep gullies on the side of the road, and if the water is taken from these ditches at every available point so as to prevent seepage of water under the surface of the road, there should be little difficulty in keeping the road in good condition. Very often it is necessary to carry the water from one side of the road to the other; and when this is necessary, it should be carried under the surface of the road by means of either concrete, metal, or terra-cotta culverts or pipe. The water should never be carried across the surface of the road, for it keeps the surface soft, is apt to flow down the surface of the road unless prevented by high rock, and is a great inconvenience to travel. Plate III, A and B, shows a surface ditch with lower side so high that it would be apt to stall a heavily loaded team. Wooden culverts should be avoided, if possible, and where necessary to use them they should be made of good timber and all planks securely nailed. They should be examined constantly so that they can be kept in good condition. The surface of the road should be kept as near flush with the surface of the culvert as possible.

After the system of drainage has been installed, provision should be made to keep it up, so that the drains and the culverts will not become stopped up.

The surface of a dirt road should be kept of dirt, and whenever any holes or ruts have developed in the road they should not be filled up with stone or brush, but with dirt, and with dirt as nearly as possible of the same character as that composing the surface of the balance of the road. If, on the other hand, holes or ruts are filled with rock, gravel, or brush, the wearing effect will be uneven, and the wheels will begin to scoop and cut out holes just beyond or on the opposite side of the road from the hole filled up. If there are stumps or rocks in the road, they should all be removed, so that the dirt surface can be smoothed over and brought to an even slope from the center to the ditches. Plate III B represents a road that it is impossible to maintain properly on account of the stumps. After the road has been well constructed and the right slope and surface obtained, it can be kept in this condition very readily by judicious application of the split-log or King drag. This simple road machine, if used regularly after a rain when the roadbed is wet, will smooth and shape up the road, so that as soon as it has dried out it will be firm and hard. The drag will fill up the ruts and holes



A.—Surface ditch in dirt road for carrying water from one side to another. This ditch should not be used, and the water should be carried under the surface by means of a culvert.



B.—Road where surface contains a great many stumps. Such a road cannot be maintained properly.

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A.—Old way of throwing dirt from ditches on side of road, preventing drainage from road into ditch. This scene is in Craven County.



B.—Wayne County farmer using the public road for a turning place for cultivator, thereby damaging the road.

and will keep the dirt road in first-class condition, with hard surface, throughout nearly the whole year. Plate IV A and B.

As moisture is very detrimental to a dirt road, the sun should be permitted to strike the surface of a dirt road as much as possible; and, therefore, care should be taken not to have too much shade along a dirt road, and, where necessary, the trees should be cut away so that the whole surface of the road is exposed to the sun for at least several hours during the day. Shade is good for a macadam road, but too much shade is bad for a dirt road. This does not mean that all trees should be cut from alongside of a dirt road and thus destroy, to a large extent, the beauty of a highway, but it does mean that sufficient trees should be cut so that there will be no part of the road surface but what will be exposed to the sun for a part of the day.

In repairing a dirt road the same thought must be given as in its construction, and, when cleaning out ditches, the material should not be thrown into the middle of the road or on any part of the surface of the road, but it should be thrown into the adjoining fields, for this material is usually composed largely of fine silt and vegetable material, which holds moisture like a sponge and becomes very difficult to dry out, and is entirely different in character and consistency from the dirt surface of the road. How many times we have seen the dirt road repaired by this material being thrown up into the center or just beyond the edge of the ditch, thus preventing the surface water from flowing into the ditches, and often turning it down the road!

In the maintenance of our dirt roads they should be divided into sections, with a foreman or overseer in charge of each section, whose duties should be to go over every mile of his section after every rain and at least every two weeks, and wherever he finds a portion of the road needing repair, he should have it done. After each heavy rain he should run a road drag over the road in order to bring it into shape and to fill up any ruts or holes that might have been started. We must bear in mind that roads will not maintain themselves, and that repairing a road simply once a year will not keep it in good condition.

The cost of maintenance of the public road is often increased by the farmers using the road as a turning place when plowing, harrowing, or cultivating their fields. County and township road commissioners should not permit this, as the farm implements carry a certain amount of soil into the ditches and onto the road. Plate V illustrates this use of the public road which should be prohibited.

In Repairing a Dirt Road.—Don't fill up the holes and ruts in the dirt road with brush, with rocks on top, and a little dirt to cover the rocks; but fill up the hole with dirt of the same character as the balance of the road.

Don't throw all the refuse from the ditches into the middle of the road, thus softening the surface and destroying the solid, firm bed that you have obtained by previous work; but throw this material out on the opposite side of the ditch.

Don't leave the center of the road the lowest point; but make it the highest and give the surface of the road a slope of about 1 in 20 to the side ditch.

Don't carry the water across the surface of the road from one side to the other; but carry it by means of culverts underneath the road.

Don't have grades on your road over $4\frac{1}{2}$ per cent; for if you do it will be

necessary to build V-shaped surface ditches or "Thank-you-mams" across the road.

Don't, in working out the labor tax on the roads, try to make a holiday of it; but give an honest day's work on the road. Let us eliminate what is often seen in those sections where the roads are maintained by the labor tax—ten or twelve men and an overseer, a little gray mule, a small plow, six dogs, three or four guns, and a few tools which often are not considered worth using at home. This road force is not only hard on the rabbits, but also hard on the roads.

Don't reject the split-log drag because it is a cheap road machine, but use it constantly, for it is the most efficient road machine that we can use in maintaining the dirt road.

Drainage of Roads.

By T. F. HICKERSON.

Drainage is a very important matter to be considered in connection with the location, construction, and maintenance of roads, since no road, whether earth or stone, can long remain good without it. Drainage alone will often change a bad earth road to a good one, while the best stone road may be destroyed by the absence of proper drainage. Water is the natural enemy of roads, especially earth roads, for, mixed with dirt, it makes mud. Also, if the water is allowed to flow down the middle of the road, it will wash away the earth and leave gullies. No road, however well made otherwise, can endure if water collects or remains on it or even near it. Prompt and thorough drainage is a vital essential in all road construction, and particularly so for earth roads.

A perfectly drained road will have three systems of drainage, each of which should receive due consideration. This is true whether the trackway is to be macadam, brick, concrete, gravel, sand-clay, or earth, and it is emphatically true of earth. These three systems are underdrainage, side ditches, and surface drainage.

The object of artificial underdrainage is to remove the water from the soil directly underneath the road surface in places where there is no natural underdrainage, because an undrained soil is a poor foundation, while a dry subsoil can support almost any load.

A good method of securing underdrainage is to lay a line of terra cotta tile three or four feet deep on one or both sides of the roadway. The tile should be at least four or five inches in diameter, and laid on a uniform grade. The tile drain satisfactorily when the fall is only one inch per 100 feet.

In special cases across swampy country, a corduroy or mattress foundation, covered with a deep fill of gravel or large stone has given satisfaction.

SIDE DITCHES.

The side ditches are to receive the water from the surface of the traveled way, and intercept water that might otherwise flow from the side hills upon the road. The ditches should be on a uniform grade, in order to admit of the water flowing readily into culverts or entirely away from the road. Ordinarily they need not be deep; but should have a broad flaring side toward the traveled way, to prevent accident if a vehicle should be crowded to the extreme side of the roadway. The outside bank should be flat enough to prevent caving.

When the grade on earth roads is over $4\frac{1}{2}$ per cent, the side ditches are apt to wash deeper and wider so that the width of road is seriously decreased. In extreme cases, the bottom of the ditch should be paved with stone. On side hill or mountain roads, catch-water ditches should be cut on the mountain side above the road, to cut off and convey the drainage of the ground above to the neighboring ravines.

Instead of a system of underdrainage for a road over flat swampy country, the practice in some sections is to raise the subsoil above the water level by making a fill with deep ditches on each side.

SURFACE DRAINAGE.

The surface drainage is provided for by crowning the surface and keeping it smooth. The slope from the center to the sides should not be so flat that water cannot easily reach the side ditches, or so steep that vehicles turn out in passing each other with difficulty and also the side slopes will be washed into small gullies. The slope from the center to the side should vary, for earth roads, from one-half inch to the foot to one inch to the foot. If the surface is well cared for, one-half inch to the foot is advisable. As a general rule, the harder the surface, the less crown is required.

The crown should be greater on steep grades than on the more level portions, to prevent water running down the length of the road. Also, there is more reason for a greater crown for a road on a level than on a slight grade.

Drainage should often be the determining factor in the location of roads. Thus, other things being equal, a ridge route is far more desirable than a valley route. Also a road located on gravelly soil may be expected to remain dryer than one located on retentive soil.

The type of construction of a road surface is often made much more expensive in places where drainage is apt to be bad. Thus, a telford pavement of large stone carefully placed must sometimes be built instead of the ordinary macadam.

It will not be inappropriate here to say that the advantage of proper drainage led to the discovery by John London Macadam of the macadam road to take the place of the expensive type of construction used by the Romans. Macadam's idea was that a well drained foundation and a rigid and waterproof covering will withstand any load, and that idea has not changed up to the present day.

If it were not for the destructive effects of water, the maintenance of roads would be an easy proposition.

County Highway Bridges.

BY J. N. AMBLER, HIGHWAY ENGINEER OF WINSTON-SALEM.

Except in a few localities, the popular interest in "good roads," which is so widespread at the present time, did not exist, even as far back as fifteen years ago. At this time, however, there are but few counties in the State which are so bold as to put themselves on record as not favoring good roads, or as being indifferent to the benefits to be derived from them.

Roads are now being built which can take care of the heaviest modern traffic, such as motor cars, motor trucks, steam and gas tractors, and other heavy machinery.

Have the highway bridges of the country kept pace with the movement for good roads? The fact that they have not is notorious, and many of the best highways today are crippled in their usefulness by the fact that there has been little or no appreciation among county officials that the bridges should be adequate to carry the heaviest traffic which will go over the roads.

Since the old adage that the strength of a chain is no greater than that of its weakest link, applies preëminently to this question, a little reflection will show how utterly illogical it is to spend many thousands of dollars in bond issues for modern roads, while even a single bridge, let alone the great majority, are insufficient in capacity to carry modern traffic with proper safety.

At the present time the most common type of road roller, with its coal, water, driver, etc., will weigh some 21,000 to 22,000 pounds. Heavy steam and gas tractors will weigh fully as much, not counting the weight of a train of wagons which is often attached to them. These weights are also approximated by present day motor trucks, and the weights and loadings of this style of vehicle are increasing. While the 30,000 pound road roller is no longer in common use for highway work, in view of what has been said, it does not seem wise to design bridges for a concentrated load less than that which this machine would give, not only for important highways, but also for highways of secondary importance. Over and above this, an allowance of 25 per cent of the live load, for vibration and impact, should always be made. The tendency is undoubtedly toward heavier loadings in the future.

The fact that bridges have been and continue to be built in violation of the demands of existing, as well as future conditions of traffic, is partly the fault of the counties themselves, and partly of the bridge companies.

With the counties, money has been all too scarce, and interest in, and appreciation of the bridge question almost entirely lacking, up to the present time.

Now the more progressive counties are beginning to realize that the old system of letting bridge contracts is illogical and unbusiness-like, and that good results are not likely to be obtained under it.

Under the old system, the only question which had any bearing whatever on the case was "what is the cheapest bridge which can be built from the near bank to the far bank of the stream."

Loadings were not considered, proper unit stresses were unheard of, proper foundations were disregarded, adequate width was of no consequence and good looks was a matter of amusement, while the floor system and details were not worth thinking about. In other words, nothing whatever was involved in the entire question but cheapness.

Often the price was fixed in advance by the commissioners themselves, and bridge companies were told that in no case would the county pay more than \$2,000 for the bridge. Possibly an adequate bridge would have cost \$3,000 or more. Now the bridge companies are met with a choice between building the bridge so cheap that they may still make a profit, or else avoiding all such cases, and, as a result, going out of business.

Of course the first alternative is the natural one to be chosen, and then the question of skinning steel, skinning masonry, and skinning the capacity of the bridge is in order.

Now, there are certain limits below which reputable bridge companies will not skin either steel or masonry, while irresponsible companies do not seem

to recognize any such limit. The writer once heard the representative of a company, known for its cheap work, boast that his company could put up a bridge as cheap as any set of county commissioners could desire.

In support of this claim, he exhibited a large batch of blue prints, which required only a casual examination to see that his boast was thoroughly substantiated.

In such bridge lettings as have been described, the county commissioners were admired by their constituents as astute business men, who could out-trade the bridge men. Imagine a county commissioner, who knows nothing whatever of the tricky business of building bridges, getting the best of a bargain with an unscrupulous bridge company; particularly when the bridge company has both the designing and constructing the bridge in his own hands, not subject to any check on either, unless possibly that of the county surveyor, who, by virtue of his office as the only technical man in the county, is, therefore, supposed to know all about bridges.

In other cases, where the bridge was a large and important structure, enough bridge men would be present at the letting to give the air of fierce competition.

These gentlemen would have to be introduced to each other, and then each would proceed to bid on his own plans, and also on those of his competitors, until the writer has seen a confusion result, from which it would have been hard to extricate the interests of the county. Little did these commissioners suspect that under all the arguments and personal clashes between the bridge men, an understanding had been reached the night before in a nearby city, under which it was decided which company would get the contract, and that at a price sufficiently higher than a proper cost of the bridge, to allow of a snug sum to be divided up between all the "boys present."

In other words, a first-class "pool" has been pulled off over the good and unsuspecting commissioners.

At the present time there is undoubtedly competition of every character, proper and improper, in the case of small bridges, which, when unchecked, results in the skinning already explained. How far real competition may be had in the case of a large and important bridge is doubtful. It doubtless depends upon how the various companies are circumstanced at the time of bidding.

Who is to blame for this deplorable state of things? Bridge companies are certainly to blame for a pool, or any other deception, and for much of the faulty designing and construction. There are extenuating circumstances, however. They say that as long as county commissioners want only cheap bridges, they have to build them, or else go out of business, and that other practices have been forced on them by the counties. The writer has known of several instances where they have been treated with shameful injustice. In the writer's opinion the blame rests very largely on the county commissioners; also with extenuating circumstances. Commissioners should be men of sufficient intelligence to realize that bridge design and construction is a very highly technical matter; so technical as to be entirely beyond their comprehension, and should be of sufficient business experience to know that they cannot beat bridge men at their own game, a game entirely in the bridge men's hands.

Some counties have men of the intelligence and ability to appreciate these issues and who are willing to serve as county commissioners, and to them

we should look for a gradual emancipation from the present practices in bridge building.

The day for "good bridges" as an important factor in the movement for "good roads," is beginning to dawn.

Bridge companies act as engineers in designing the plans which they offer, and as contractors in building them. This places the entire matter in the hands of the company, and ordinarily the counties' interests are not represented at all, certainly by any one who knows anything whatever of bridge design and construction. Every one should know that no amount of business ability in the commissioners will take the place of technical training and experience.

In the early days of bridge building there was some excuse for the companies acting as engineers and contractors, on the same job. Bridge engineering was in its infancy; there were no adequate bridge courses at engineering colleges, and no laboratories or testing equipment for experimental work.

The bridge companies developed these subjects, and are primarily responsible for the present state of knowledge of designing and constructing bridges.

At present, however, a number of institutions offer highly practical courses in bridge engineering, and while, because of lack of demand, there are not enough engineers in the country at this time who are sufficiently experienced in bridge design to handle the bridge work everywhere, their number is increasing, and this is a great step in the right direction.

Where such engineers can be had, there is certainly no more reason why bridge companies should do both engineering and constructing, than that water works, sewer or railroad contractors should do it.

The disadvantages of the present system will never be removed until counties employ competent and experienced bridge engineers, independent of affiliation with all bridge companies, to design their bridges and supervise their construction.

All cities, who know anything of public works, as well as railroad companies and other corporations, feel and know the importance of having the services of a competent, disinterested engineer, acting in their service, and to their interests, and will not do work on any other basis.

To allow one and the same person to be both engineer and contractor, is illogical, unbusinesslike and not necessary. No certain or economical results in the interests of the counties are likely to be obtained in departing from the experience of cities, railroads and the larger corporations in this respect.

They have found that the small cost of engineering service is abundantly justified, and all are large employers of engineers.

How unlikely is it therefore, that counties, with less knowledge and experience will be able to improve on their methods, and still persist, from force of habit, in pursuing a course contrary to all business experience and the dictates of ordinary common sense.

The question may now be asked, in what respect will an engineer be able to help a county with a proposed bridge? I will answer categorically that if he is competent by training and experience, he can help in the following definite ways:

(1) In assisting them to select the site of the bridge. The importance of the traffic will determine the general situation of the bridge, but the actual

spot is best determined by the engineer, in view of length, foundations, and proper approaches at the ends, from the highways on either side.

(2) Having agreed upon the exact location, the engineer should then be instructed to make a precise survey. This will show the position of rock abutments, if any, the banks, rock ledges for piers, etc.

Accurate levels should be run over the center line of the bridge, as already staked out.

These should show the elevations of the surface of water, bottom of river entirely across, top of banks, and the slopes of the hills for some distance beyond the ends. Soundings should show the position of rock, and the highest known flood level should be ascertained and shown.

(3) With the map and profile prepared from this survey, the engineer is enabled to determine the best and most economical arrangement of spans, the type of spans best suited to the conditions, as well as the proper elevation of the bridge to escape floods.

He can also determine the proper width and height of the bridge, and the loadings for which it should be designed, as well as the safe allowance for wind and flood current. He then proceeds to work out what the stress in every separate member of the bridge is, not only for the dead load and wind load, but for the most unfavorable positions of the live load. He then works out the sizes and cross sections of the steel work to meet these stresses with safety.

Plans for the piers and abutments are worked out, and complete specifications for foundations and superstructure are made.

In the case of concrete arch bridges, the procedure is similar as to its object and result.

(4) The engineer can be of great assistance in letting the contract.

Having figured up the amount of material in the bridge, and applying current prices, he knows what the bridge ought to cost. The county commissioners have no means of knowing what the bridge ought to cost, while the bridge salesmen do know. When the county is represented by a consulting engineer, who also knows about what the bridge should cost, it is likely that a great saving will be accomplished.

If the bids on, say a steel bridge, are all unreasonably high, the engineer suspects a "pool," and is in a position to advise the county as to the practicability of building a concrete bridge, a bridge composed of short one-beam spans, or even a wooden bridge of approved type. Since concrete bridges are built by an entirely different class of contractors, and one-beam bridges can be made in any machine shop, and a wooden bridge can be built by any building contractor of experience, the county does not have to fall victim to a pool of bids.

The writer knows no other way of handling a pool as effective as to be independent of those making it.

Now, the other extreme of cut-throat competition on small bridges, resulting in giving the contract to the most unscrupulous skinner of steel, is also avoided, because the companies are all bidding on fixed plans and specifications prepared by the engineer representing the county. His design is intended to be the most economical that *should* be built, not the cheapest that *can* be built. The assistance of the engineer will also save much confusion to the counties in his telling them what bids are irregular and improper. This is also a protection to the reputable bridge companies, as it insures

them a square deal, removing the improper advantage that the shyster would have over them under the old system. If the practice recommended were pursued generally, it would do much to remove the low trickery and rascality which has often characterized bridge lettings.

Bridge building would be on a businesslike basis, and the confidence of the bidders that they would all be treated exactly alike, without fear or favor, and would get a square deal, would tend to lower the cost of bridges everywhere.

(5) After the contract has been let and signed, the engineer should be employed to give necessary supervision to construction. Since the foundation work is of the utmost importance, and lends itself so easily to deception, by insufficient care in preparing the subfoundation, leaving out cement, and putting in bad sand, and in many other ways, an inspector, working under the direction of the engineer, should be on the work at all times while the masonry is being put in; while the engineer should visit the work at intervals.

In the case of a concrete arch bridge, the most careful and persistent inspection and supervision are necessary. The fact that this supervision has usually been lacking, accounts, in the writer's opinion, for nearly all the cracking up and more or less partial failure of so many concrete bridges. Since it is impossible to tell much about concrete after it is finished, the only businesslike thing to do is to see that it is put in properly at first. In no other way can the advantages of this material be realized.

The steel work does not require constant supervision, but should be visited by the engineer at intervals, before painting. Since we assume that the bridge company's shop drawings have been approved by the engineer, and certainly in the case of an important bridge, an inspection covering the chemical and physical character of the steel has been made at the mills and shops, by one of the independent inspection bureaus, it only remains to be seen if the various members are of proper strength; that is, that they have the sizes and weights shown on the plans, and that the work is properly erected. The weights of steel can be determined by the engineer by means of a pair of calipers, and comparison with the detail thickness and other dimensions given in the mill catalogue.

The painting should be carefully specified in the plans, and inspected in the field. Railroad companies generally buy paints subject to the specifications and tests of their chemist.

An entire paper could easily be given to this subject. If practicable to apply the test, the bridge should be actually tested with the heaviest load for which it is designed.

The engineer, when satisfied that the bridge is properly built, and that the contract has been complied with, in every respect, should so certify to the county commissioners, and thereupon they should pay for the bridge promptly. The delays and difficulties in getting their money are serious grievances of which bridge companies complain. If, generally, they are treated in a fair and businesslike way in this respect, they could bid closer, and much money would be saved throughout the entire country.

Summing up the entire matter, it should be stated that building bridges is a business—a highly technical business, and to get businesslike results, an engineer, who is simply a technical business man, should be employed to assist the county commissioners, exactly as they employ a lawyer to assist them in their legal business.

It is foolish to build bridges out of keeping with the roads on which they are situated, and which will not handle present and future traffic demands.

Since county commissioners cannot be expected to know how to design or construct bridges, any more than they can be expected to know how to handle a legal battle, it is logical to employ some one whose training and experience enables him to assist them to get safe, sure and economical results with the bridges of the county. It is reasonably sure that no such results can be depended on under the present system of seeing who can prepare the cheapest, and, therefore, weakest design.

The writer wishes to see a realization by all counties of the fact that past conditions should be, and can be remedied, that all bridges should be designed by competent engineers who represent the counties, that all bridge companies should bid on the same basis, and no sneak bids be received, or other features allowed which would tend to destroy the confidence of the bidders that they are being treated with perfect fairness, and that the construction work be supervised and accepted by an engineer, and the bridge companies be paid promptly, and in full.

The officials of several of the most reputable bridge companies, with whom the writer has discussed the situation, have expressed their belief that it was not only best for the counties to have their plans prepared by an engineer, provided he was competent to design bridges, but also for their companies, as a reputable company is usually well equipped with machinery and appliances and with their organization can put in a lower bid on a fixed set of plans, than the shyster can.

In other words, this plan, if carried out, would put a premium on the company best equipped to do the work, rather than on the shyster who is poorly equipped.

It goes without saying, however, that the plan, as outlined, will be fought bitterly by the shyster, because it is an invasion of his field of activities, and tends to creating conditions which will take the premium off of his methods. When he is confronted with a set of plans and is told that his bid must be on them, or on none, he is deprived of the advantage previously enjoyed of preparing a plan of his own so cheap and weak that his reputable competitors (who have sufficient tangible property to be liable) cannot follow him.

He is also deprived of designing the bridge to use such old remnants of steel shapes of various sizes and character as he may have left on his yards.

There is nothing for him to do but to attack the ability of the engineer, and see if he can't get in such close personal touch with some of the commissioners, who think that engineering is nothing but nonsense, anyway, as to create a doubt in their minds as to the plans.

Sometimes the opposite course is pursued, the engineer is highly praised, and the design is pronounced a most superior one indeed. However, it is pointed out, "You commissioners can't afford to build a bridge like that. Why we can put up one for not much over half of what that one costs." They speak truth, for they not only can, but will do this very thing if allowed to do so.

A good answer for the commissioners to give is that our engineer states that he also can design one to cost half as much as this, and if necessary, could design one even lighter still, so light, in fact, that he would not dare

drive over it himself, when completed; but he states that the bridge, as designed, is as light a one as we should build, in the interest of the people.

While the course outlined in this paper is aimed primarily at benefitting the counties, it cannot fail to be of benefit to all bridge companies who take pride in their work and are willing to give a square deal themselves.

For one to oppose a movement intended to put bridge building on a more honorable and businesslike basis, with fairer and more certain results, for the company and county alike, would seem to the writer to be an admission by the company, that they were not in that class to which such an appeal could be made.

The writer will never cease to bring the importance of "Good Bridges" to the attention of county officials, as far as his limited ability with word and pen allows, and if this paper has in any way awakened interest in this long neglected subject, he will be satisfied.

Culverts.

BY R. T. BROWN, HIGHWAY AND ROAD SUPERINTENDENT, ORANGE COUNTY.

There has been such excellent material on the subject of culverts, published by the U. S. Office of Public Roads, by many of the State Highway Departments, by the manufacturers of the various kinds of culverts, and in the road magazines that it seems rather useless to attempt to bring out anything new or of especial interest on the subject.

For convenience, culverts are classed under the following heads:

1. Wood Culverts.
2. Stone Culverts.
3. Brick Culverts.
4. Vitrified Pipe Culverts.
5. Concrete Culverts.
6. Metal Culverts.

This classification is probably not arranged in point of relative merit, but rather in the order of development, which is also in a general way the order of merit.

WOOD CULVERTS.

By some builders of culverts the wood culvert is disregarded as a thing of the past and not of sufficient worth to be used in this day of more enduring forms of construction. By others it is used as the chief means of drainage. I take it that neither extreme is practicable in all cases. But I do think that wood culverts in any road that presumes to be a permanent way of travel for the public should be discarded as rapidly as they may be economically replaced by something more lasting. For temporary purposes in light construction and for repairs of accidents to culverts on roads that must be kept open continuously wood culverts may often be used to advantage until material can be obtained for a more enduring type. However, the temptation is to leave the wood culvert in just as long as it will hold together. This is especially true of those in roads kept up by the spasmodic kind of overseer we have in this part of the country. He lets all the culverts get in just as bad condition as the public will endure, and then takes a spell at repairing them. He has not previously provided any material for the needed repairs

and consequently he must go to the nearest saw mill and scrape up enough stuff to make his repairs and let the sawyer make out a bill for whatever he thinks he ought to have for it.

STONE CULVERTS.

Under the heading, stone culverts, I would include those of dressed or faced stone and those of rubble masonry laid in mortar. (And I would not recommend using stone in any form in a culvert without its being held in place by means of reasonably good cement mortar.) An exception might be made in the case of a drain of large and small stones sometimes used to carry the stream from a very small spring, if this may be classed as a culvert.

In ordinary highway construction, where the work is often done without the constant supervision of an inspector, and usually by contractors whose chief desire seems to be to use as little cement as possible, it is not advisable to build stone culverts of greater than four or five feet spans. On scenic highways and those on which it is desired to keep the artistic features prominent, stone may be used with good results if it can be obtained in proper shapes and if the necessary care is used in the construction.

In all cases where there is much fall in the stream bed and the foundation is of such a nature as to erode to any considerable extent, the waterway of stone culverts should be either paved with broad, heavy stones or grouted to a depth of five or six inches. This paving should extend some distance below the end of the walls, so that they will not be undermined at the outlet.

I have found that a fairly good and economical manner of constructing the walls of small stone culverts and also abutments for small bridges is to build up the faces of the wall with the larger, better shaped stones and fill in the center with small stones and grout, that is, rather thin cement mortar. This avoids the use of forms and at the same time gives a pleasing looking face to the wall if the work is properly done.

One fault of many stone layers is that they want to skimp the mortar in the body and the back of the wall, and then point it up carefully on the face to make a good looking job. It would be better for the culvert if they put the extra mortar in the back instead of on the outside; for when there are voids in the stone at the back and the front is plastered up so that the water that gets in from behind can not get out at the face, the wall is very likely to be destroyed by the freezing of the water.

Unless plenty of large stones can be obtained, stone box culverts should not be built over three or four feet spans. Above this size the top should be arched and supported until the mortar is thoroughly set. Unless the foundation is of solid rock, the bases of the walls of an arch culvert must be spread far back into the fill to avoid settling from the thrust of the arch, and the consequent cracking of the culvert.

BRICK CULVERTS.

Brick culverts are probably suited to parks and private grounds better than to use in general road construction. Unless a very good grade of brick is used and great care is used to have all voids filled with good cement mortar, this type of culvert will quickly disintegrate. It is not an unusual thing to see the headwalls of a brick culvert beginning to tumble down in a few years after they are built. On account of the uniformity of size and color, brick can be used to give a very artistic construction. But if the work is poorly done,

a brick headwall is about the cheapest looking thing one could see on an improved highway. The same thing may be said of a brick culvert as of stone, that the failure of a single brick may mean the collapse of a large area, and may necessitate the reconstruction of the whole culvert.

One strong objection to the use of brick culverts is the time required to construct them even when of small area. Often a culvert is needed at once so that grading can proceed over it immediately. It is, to say the least, risky to allow earth to be dumped carelessly on a newly constructed brick culvert. It should, instead, be placed by hand and thoroughly rammed until a layer of sufficient thickness is obtained to carry the shock of a concentrated load.

VITRIFIED PIPE CULVERTS.

Under certain conditions, vitrified pipe makes a very good and permanent culvert. Within itself, well burned terra cotta is practically everlasting. It is not affected by acids or alkalis that are present in ordinary soils. It presents a smooth surface, thus offering little resistance to flowing water. It is of sufficient hardness to resist considerable eroding action of sand in the current. But it will break. It breaks when being loaded on the car, while in transportation, when being unloaded, when being hauled to the culvert site, when being rolled into the ditch, and when a heavily loaded wagon jumps over a little rock and onto it.

But if it is installed under a fill of the requisite height to give it sufficient protection, and is otherwise properly placed, it makes a lasting culvert. This is very important as vitrified pipe is entirely unsuited for use near the surface both on account of liability to crushing and to freezing. It has been my experience that most of the failures of vitrified pipe culverts have been due to improper installation rather than to worthless pipe. Many road builders seem to think that clay mud is a perfectly good filling for the bells after the pipe is in place. I have seen many supervisors have rock put all around and on top of the pipe to hold it in place and to prevent wagons from getting to it and breaking it. No more absurd things could be done. The clay washes out of the bells, the rocks allow the water to run around the pipe, thus giving it every opportunity to wash out the roadbed, and one little rock gets in the exact position for the wheel of a heavily loaded wagon to drop off a larger one and punch a nice hold in the pipe. I have seen cases in which the water ran out so fast at the leaks that none came out at the lower end. Certainly this was not the fault of the pipe, except in so far as it has too many joints.

Unless the foundation under a vitrified pipe culvert is pretty uniform and the earth is properly rammed underneath, it is likely to settle unevenly. This often allows silt to accumulate, with the result that the pipe is finally clogged. I take it for granted that no one in this body would install a vitrified pipe culvert as I saw one placed in a nearby town recently—with the bells down stream. Even the best grade of clay caulking would soon be washed out of that. Of course, if the joints were all filled, as they should always be, with good cement mortar, this arrangement might hold, but it would be much better from any consideration to have the bells upstream.

CONCRETE CULVERTS.

Concrete is, of course, the most adaptable of materials for culvert construction. It can be used for as small and as large spans as desired, if properly reinforced. It can be made as artistic as funds available will permit. It can be made as strong and rigid as the circumstances require, and it is probably the most permanent of any of the types mentioned.

The chief reason for its not being used more than it is at present is its cost. It is usually necessary to construct forms for the culvert before making the culvert, so that many builders prefer to let one building do, and hence use some other material. When the use of metal forms becomes more general and work can be so arranged that a few sets of forms can be used over large areas, such as whole counties, the construction of concrete culverts will become more common. There is an idea among many township supervisors that concrete is a material to be used only by the highly skilled laborers, and they are afraid to attempt its use. As a matter of fact, the labor required for concrete construction need not be any more skilled than that for moving dirt and laying pipe, but to be properly used it needs faithful labor. After learning something of the properties of different kinds of sands and the proper proportions for various purposes, the matter resolves itself into exercising the necessary care to get the mixture uniform and depositing it in properly built forms. The one great trouble in concrete work is to get it mixed thoroughly. I once gave a man who was mixing for me a rule by which to get it thoroughly mixed. I told him to turn it until he was absolutely sure that each grain of sand was coated with cement and each piece of stone covered with mortar and then to continue as much longer as he had had been at it. Not only should the materials be well mixed before water is added, and while it is being added, but it should also be stirred frequently while being deposited in the forms.

While concrete is very hard to resist wear and strong to stand crushing stresses, it is well known that it does not resist tensile or bending stresses very well. As the top or slab of a culvert must carry bending stresses, provision must be made to carry them by means of reinforcing metal. The form of reinforcing steel most convenient for use in small culverts is that of round bars or some of the patented types of deformed bars. Expanded metal is also used in connection with rods in many sections of the country; but, if it is desired to use some large stones for filling, the mesh metal is likely to be in the way. Then, again, it is easier to get the ordinary laborer to place rods properly and to keep them there than is the case with woven or mesh metal. A principle to be always remembered in placing reinforcing steel is that it is to be nearest the side towards which the slab would bulge when weight or any pressure comes on it. Recently a man who is working on our forces wanted to bend the half-inch reinforcing rods upward in the form of an arch. If the rods had been as strong as railroad rails, his method would have possibly served, but with half-inch rods it would have been of absolutely no value unless it were to hold the two pieces together after the slab had broken.

As we have no means of crushing stone for our concrete culverts except by hand hammers, I have built many of the walls of my culverts as simple rubble masonry walls; then built a form an inch or so below the tops of the side walls on which to construct the slab. I allowed the steel rods to project onto

the tops of the walls and, when possible, to anchor in them. By leaving projecting stones on top of the wall, the slab can be very thoroughly bonded to it. It is well in using this form of construction to place short pieces of rods in the wall when finishing it and then to bend the cross rods around these in the wall.

Of course, the slab can be made thick enough to carry any reasonably heavy load without the use of reinforcing steel, but it is more economical to use the steel, and there is greater safety in using it than in depending on the concrete alone to carry all stresses.

Concrete pipe, made similar to terra cotta pipe, is now being used to some extent for culverts. It has the advantage of being stronger than terra cotta in addition to the qualities they possess in common. If it is known long enough beforehand what sizes will be required, molds can be bought or made and the pipe manufactured by the user. If a good quality of sand or of stone screenings is available, this type of culvert can be made at a reasonably low cost. The pipes should be protected from the sun while curing, and should not be used for at least thirty days after being molded.

Not having used this type of culvert, the writer is not prepared to give comparative costs. The cost of hauling and installing is obviously about the same as for terra cotta under similar conditions.

METAL PIPE CULVERTS.

Cast iron pipe has been used by railroads and in some other places for many years. Its great strength and rigidity make it especially suited for use under high fills and in places where there are heavy concentrated loads to be carried, and its durability warrants its use in construction that is intended to last indefinitely. Its cost and great weight, however, prevent its general use in highway construction except under very high fills. There are now a few firms who manufacture ribbed cast iron pipe that has practically the same effective strength as the smooth pipe and is at the same time much lighter. There would rarely occur in a single county enough cases where cast iron pipe would be required to justify the purchase of it in car lots.

The manufacture of culvert pipe from corrugated sheet metal is of comparatively recent origin. It has been called forth by the widespread interest in road improvement that is also of recent development. In fact, this type of culvert has not been in use long enough and under sufficiently varied conditions to make us perfectly sure that it will last as long as is claimed for it. But in spite of the lack of information, based on long experience, corrugated metal culverts are being used a great deal, not only in highway construction but also in railroad, street railway, and interurban lines.

There are reasons to believe, and the information we have thus far obtained from experience tends to support this belief, that if culverts are properly constructed of the most nearly pure iron obtainable, their life will be sufficient to justify the original cost. To make sure that these culverts shall be of the highest efficiency, as much care should be exercised in the mechanical construction as in the selection of the material. It would be folly to put into a culvert metal that would last a hundred years and to rivet it together so poorly that it would be broken by the settlement of a heavy fill, or to use such light gauge material that it would be easily crushed. It is also quite important that the rivets, bolts, and connecting bands or angles be of the

same material as the body of the culvert. All parts of the culvert should be coated thoroughly with spelter; for if the metal will endure because of its rust resisting qualities, it will be still further protected by the spelter.

Corrugated pure iron culverts probably combine more desirable qualities than any other one type, though some of these qualities are not quite so characteristic of this type as of some others. Thus the corrugated culvert is light, strong, easily and quickly installed, can be secured in various lengths, stands handling fairly well, is water tight when properly laid, can be taken up and moved if necessary, and, so far as we know, lasts for a considerable period. It can be quickly unloaded from the car and hauled in large quantities at a load. The ease of installing it and its resistance to crushing allow it to be placed immediately ahead of the grading and the fill dumped on at once. This is an especial advantage when the work follows an old road that must not be obstructed too far ahead of the grading force.

Steel has been used to some extent for corrugated culverts. It is entirely unsuited for this purpose and should not be used under any circumstances for permanent highway work.

AREAS.

One of the most important considerations in regard to any culvert is the area of its opening. Many rules and formulas have been devised for giving the approximate area of culvert required for various drainage areas and conditions. Some of these, when compared, give such widely varying results that they should only be used with a full understanding of the conditions for which they are suited, and judgment must be used to adapt them for local conditions. Dickens' formula for the maximum run-off in cubic feet per second for various kinds of surface is given below. After the probable run-off is computed, the required area of culvert can be found from tables furnished by various manufacturers.

Dickens' Formula.

$$D = \frac{C^4}{M^3}$$

D = discharge in cubic feet per second.

C = 200 for flat country; 250 for rolling country; 300 for hilly country.

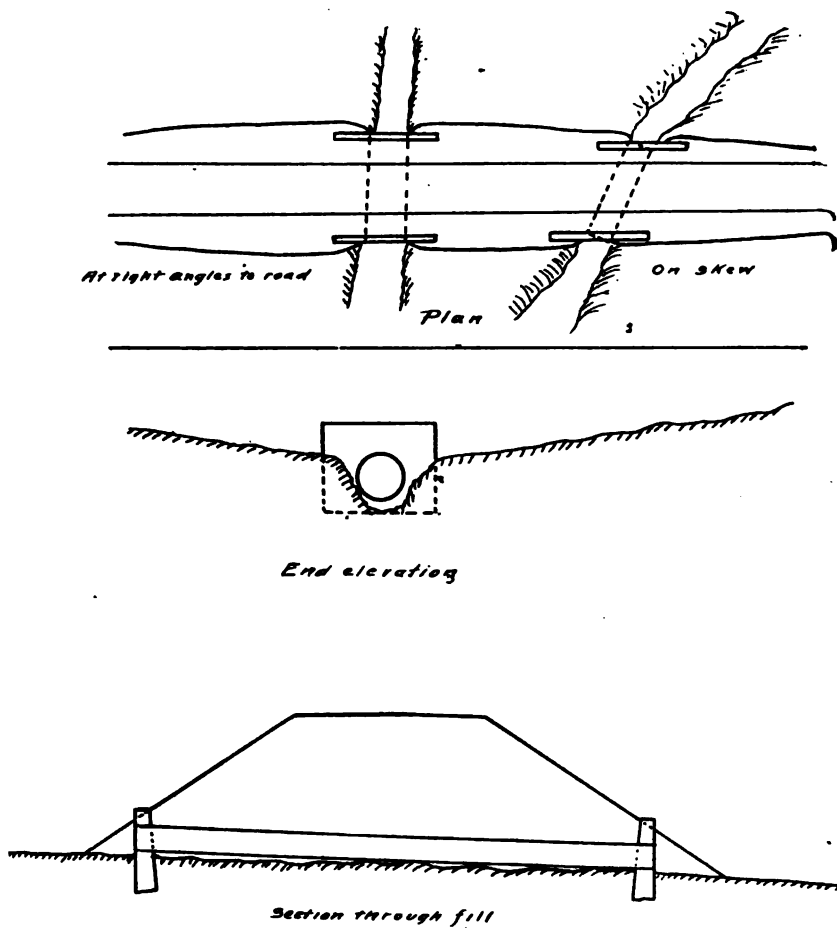
M = area in square miles, or acres divided by 640.

The safest guide for the required area is information obtained on the ground from existing culverts and bridges and from high water marks. It is better to be on the safe side in designing culverts, as the areas are likely to be partially closed up by rubbish and the capacity thus rendered less than that for which it was designed.

LENGTHS.

The required length for any particular culvert can best be determined from the ground after the slope stakes are set. It depends not only on the height of the fill, but also on the angle of the culvert with the roadway. When possible, the culvert should be at right angles to the roadway. The length of pipe culverts should be from three to five feet less than the distance from toe to toe of the fill along the direction of the culvert. This will allow the headwalls to set back in the fill, as shown in the illustration for headwalls.

For the purpose of a preliminary estimate, the following method is con-



*SKETCHES of HEADWALLS
For Pipe Culverts*

FIGURE 15.—Sketches for Headwalls for Pipe Culverts.

venient for obtaining the length. Find from the profile the distance from the top of the fill to the top of the culvert. Take twice the horizontal distance on the slope for this height of fill and add to the width of fill from shoulder to shoulder. A cross section sketch of the fill may be drawn to scale and the required length at any depth scaled from this sketch. If the culvert is on a skew, the length obtained above must be multiplied by the co-secant of the angle it makes with the center line.

HEADWALLS.

I think it may be laid down as a general principle that all pipe culverts should have a headwall of either concrete, stone or brick at the inlet end. If the culvert is under a shallow fill or at the intersection of two roads, it should have walls at both ends to prevent crushing of the ends by vehicles. I use stone headwalls at each end on all my culverts. They tend to prevent clogging of the culvert by the fill over-running the ends of the pipe, and to keep the water from running around the outside of the pipe and washing out the fill. I have seen in more than one case the inlet end of a corrugated pipe lifted bodily out of place by the force of the water. This would not have occurred if headwalls had been built.

The pipe should be of such length that the headwalls will set back in the fill, so that the outside of the wall will be within the toe of the fill. It is unsightly to have a wall standing like a tombstone clear out beyond the toe of the slope. I give herewith a sketch of the general design used in this county. (Fig. 15.)

RELATIVE COSTS.

At first, the cost of wood is probably somewhat cheaper under ordinary conditions than terra cotta. But when the frequent renewals and the possible inconvenience to traffic by failure of the culvert are taken into consideration, I think the additional cost is justified, even when a small amount of money must be expended over a large amount of road.

The cost of stone and metal culverts is higher, but in new work, especially, some of these types should be used, unless conditions are suitable for terra cotta.

The cost of each of the types for the equivalent of a twelve-inch circular pipe runs about as follows: (This is for the culvert f.o.b. nearest station.)

Wood, including constructing.....	\$.20 to \$.25	per ft.
Vitrified pipe .....	.20 to .22½	
Stone, complete in place.....	.50 to .75	
Concrete, complete in place.....	.75 to 1.00	
Cast iron f. o. b.....	1.00 to 1.25	
Corrugated iron, f. o. b.....	.50 to .65	

Owing to the different costs for hauling, the ratios of costs for the different culverts at the site will be somewhat different from those given above. This is where the difference in price between wood and terra cotta comes in.

From the records on work, on one job now being done I find that for corrugated pipe the cost per foot for installing complete with headwalls averaged slightly over 40 cents per foot. This includes hauling pipe and cement twelve miles, cost of sand and cement, hauling sand and stone, cost of labor and supervision. The sizes on this job range from 12 inches to

30 inches, about one-third of it being 12-inch pipe and one-sixth each of the 15-inch and 24-inch sizes. This covered a distance of three miles on average hilly country, at a total cost of about \$260, or at the rate of \$87 per mile.

Road Machinery Required in County Road Construction.

By N. C. HUGHES, JR., HIGHWAY ENGINEER AND SUPERINTENDENT HIGHWAYS,
HALIFAX COUNTY.

Mr. Chairman and Fellow Road Engineers:

For the past two days we have listened with much interest and profit to able discussions on the subject of Highway Construction, from the standpoint of location, drainage, use and class of material, and that of economy in construction, and methods of finance.

We come now to the discussion of the subject of road machinery required in county road construction, to which I invite your attention and indulgence. It shall be my purpose to make the discussion as brief as shall be consistent with covering the ground as fully as I can.

No road engineer or superintendent has ever undertaken the problem of road construction, I dare say, without coming to know that the class and variety, and the quality of that variety, of equipment necessary in road building are very essential factors in economically as well as constructively effecting results. The time is in the distant past, let us hope, when merely a dump car or one-team wagon, with shovels, hoes, and axes, and now and then the use of a one- or two-horse turning plow fulfilled the necessary equipment of the so-called building of roads. Experience has taught those who have, as we may say, "been to the grind," that the essential and all-round efficient equipment for highway construction is that composed chiefly of teams and machinery, with, of course, the labor required to operate both. It is now no longer contended that the same results can be accomplished in the same length of time and under the same conditions, with man power as with mule power and machinery. Therefore, when the proposition arises for the removing of earth either for excavating or for embankment or for surfacing material, for the sake of economy and rapidity we resort to the use of the drag scraper or wheeled scraper, better known in the vernacular of the road gang as "scoops and wheelers," respectively, instead of the dump cart or wagon and shovels. It has been estimated that a cubic yard of earth can be removed for a distance of from one to three hundred feet with a scoop, carrying five cubic feet, at from one-half to two-thirds the cost of removal of the same with teams and wagons or carts loaded with shovels, and for a distance of from three hundred to one thousand feet with a wheeler, carrying from twelve to thirteen cubic feet, practically a half yard, at a load, at a cost within the same ratio. The scoops for short hauls as above noted are more economical as a rule than the wheelers, so much being saved both in time in unloading and turning, and in expense of the snatch-team. The wheeler is the more economical when the haul runs from three hundred to one thousand feet, and possibly twelve hundred feet, by reason of the fact that the scoop does not carry enough material at a load to justify pulling it that far. When the haul on material exceeds one thousand feet, generally, it is economy to abandon wheelers for wagons which carry at least one solid cubic yard at a load, and preferably, where the soil over which the hauling must be done will permit, for the automatic dump wagons of from two to

three yard capacity. But since a two yard wagon loaded with earth ordinarily moist will weigh, outside of the weight of the wagon, over two and one-half tons, and a three yard wagon loaded, something over four tons, it is merely a question of whether or not, the distance of haul and the character of the route being taken into consideration, it is feasible for the teams.

In the case of excavation, in order to get at the earth with ease and remove it with rapidity, without undue strain on the loader and the teams, the earth should first be deeply plowed. For this work a four- or six-horse grading plow, with beam of wood or cast steel, should be used. When the proposition is the removal of a stiff red clay, or a clay full of coarse grit or gravel, or a subsoil hard-pan, or a gravel soil naturally close set, it is not only advisable but necessary to loosen up the soil in some way before the plow will take it. To effect this, no tool is better than a four- or six-horse Rooter plow. Both this plow and the grader are also necessary tools when the conditions require the scarifying or plowing-up of an old, hard-set, rutty road bed, regardless of what the natural material in the road-bed happens to be. Sometimes it is possible to remove a sandy or loam soil out of an old road bed to waste, or from a pit for surfacing purposes, without this previous rooting or plowing, but, as a rule, for the teams' sake, even then it is advisable.

Assuming that we are constructing a sand-clay road, and the rough and heavy earthwork necessary in completing the subgrade has been effected by means of the above-mentioned tools or machinery, and the surfacing material has been properly placed and well plowed into the subsoil, as the case may require, with the grading plow or a lighter turning plow, the next tool of prime importance for insuring that the mixture of materials and the depth and width of the mixture shall be uniform is the disc harrow. This should have not less than ten discs, and preferably twelve or even fourteen, for the wider the base the more rapid the operation, and the heavier the machine the deeper the cut and therefore the more thorough the mixture. This harrowing also serves to a large degree to fill up an innumerable number of unseen voids and smooth out surface undulations. After this operation, it is always well to run a heavy spike-tooth harrow once or twice over the surfaced portion to more thoroughly mix the soils and even up the surface. This harrow is also very serviceable in dragging out grasses and roots.

This work having been accomplished, the road bed is now in prime shape for the proper shaping-up and crowning. This calls for the road machine. There are manufactured three different sizes of these, one for a two to four horses, one for four to eight horses, and one for from twelve horses to a traction engine. As to the two- to four-horse machine, when used as a two-horse machine, it may safely be said to be impracticable; but when used as a four-horse machine it is very efficient and, in many instances, is more economical than a larger machine. But, as a rule, it is perhaps more economical to use the six- to eight-horse machine, on account of its greater stability, length of blade, and extent of wheel base. In the smaller machine the blade is only six feet long, in the larger one it is seven. Therefore, for shaping-up, crowning and dressing off a road bed, there are three reasons chiefly which are in favor of the larger machine. First, there is less liability of breakage against underground stumps, rocks and roots and less shying off from obstacles of whatever nature. Second, the difference in the amount of road surface covered in the run of a day more than compensates for the small additional cost of extra teams and labor. Third, and not the least

important to the final development of the road bed, is the greater length of the wheel base. It is readily seen that the greater the base the less frequently the machine answers to the little irregularities of the rough surface ahead of the machine when the wheels come to pass over them. And consequently, the result is bound to be a smoother surface throughout the length and breadth of the road bed. On the other hand, in cutting out lateral drains, where only a V ditch is necessary, the lighter machine is just as good and sometimes better, as it is possible to work with it in a smaller space, a condition which very often has to be dealt with. If it be a case of choice between these two sizes, it is, perhaps, advisable to have the larger machine. But the better thing is to have both on the job, for there are times when one is needed where the construction is going on and one where at the same time the roads already finished need redressing. Either one is very effective at times in conveying surplus material for short distances, grading off bumps in the roadway, backfilling a trench from which clay for surfacing has been obtained along the roadside, knocking down a crown that has become too high, and for removing snow from the road bed. The road machine is also indispensable in levelling up subgrades prior to the placing of the surfacing materials. There are some instances where the use of a road machine on an ordinary dirt county road is practicable, but these instances are very much in the minority. As a rule the roads are so uneven and full of hard bumps, roots, stumps and rocks, both surface and under ground, and tufts and mats of roadside grass, that it would cost any ordinary man his religion to try to reshape them, especially with untrained men as drivers and mismatched teams at the draft. It is indeed a mistaken idea that just any old kind of road can be machined and reshaped by the road machine. There must first be done some grubbing and plowing and filling in of low places. To a large degree this same can be said in the use of the road drag on this class of roads. You have only to ask the man who has tried it one time. A Tractor Machine, under certain conditions, may be economically used in road construction. But this necessitates a traction engine at the draft, either steam or gas, preferably the first, since the latter has not yet reached the stage of certainty of operation. But both of these are very expensive machines at first cost. And unless the extent of the work is great enough to justify the sending of the engine to the junk heap after the completion of the work, it is, no doubt, not advisable to load up on such expensive machinery. It is a much easier matter to dispose of a surplus amount of mule flesh, though depreciated in value from usage, at a reasonable price than a second hand traction engine. Yet if it be feasible, a combination Tractor and Roller would not be out of place, since, after the completion of the work, the Roller could be most effectively used in the upkeep of gravel roads, and, in all probability, in that of some classes of sand-clay roads.

And now as to the use of a steam roller in road building. The question has often been asked if a steam roller is not as practicable and even as necessary in the construction of a sand-clay road as in gravel work. From a theoretical standpoint the writer thinks not. If the clay or sand surfacing is placed in layers of from three to four inches and rolled after being mixed with the subsoil, this solid base will, of necessity, have to be partially, if not wholly destroyed when it comes to applying and mixing the next layer. And if the whole amount of surfacing is placed at once, mixed and then rolled, the effect will be to compress it only so deep, leaving, as it were, a cushion

underneath which is subject to the underground moisture and therefore the capillary attraction which is bound to follow. This condition gives rise to a giving away of the top hard rolled surface under heavy travel in an uneven manner, thereby producing rapidly a very uneven surface, and one which is hard to repair. And since, too, experience has shown that, let the mixture of sand and clay be made as thoroughly as is possible during the construction, there has still got to come the puddling to get the desired result, it appears to be reasonable that the use of the roller in sand-clay construction is a useless expense, if not a detriment to obtaining good results. Yet I believe that a steam roller may be used very effectively on a completed sand-clay surface at a certain stage of the game, that is, after it has become well set from the subgrade up to within from one to two inches of the surface. If it is then rolled, after the road machine or drag, a very even and hard surface may be produced. Certainly, however, a roller is most effective, not to say essential, in the construction of a gravel road. Some road builders claim that the compressing of the gravels is accomplished as well with the heavily loaded, wide tired wagons passing over the material already placed as with a roller, and in some instances better. But this is doubtful, since the roller is bound to produce a more uniformly compact surface than the irregular passing to and fro of the wagons.

Experience has shown that, after a gravel or sand-clay road has been completed, and a redressing becomes necessary, the road machine will produce better results for a while than the running of the drag. To illustrate: After a sand-clay road has become cut up a time or two after completion, so to speak, and has just begun to dry out, a vast number of small, hard bumps and lumps appear on the surface, making it very uneven. These are for the most part cemented to the surface, and sometimes stoutly enough so to partially, if not almost wholly, resist the drag as it comes along, and the result is that the drag merely slides over them or shaves them off just enough to make it necessary to re-run and re-run the drag over the same ground. And this can not always be done at times when needed. But the machine will clip off all these rough places, gather up the surplus amount of material from that spot and convey it to some spot where it is needed. But while the split-log or timber drag, or steel drag, with or without lever attachment, certainly is not, as is sometimes thought by many, a panacea for all road ills, and will sometimes do more harm than good, when run at the improper stage of the dampness or dryness of the surface, it is a great benefactor and wonderful discovery, and a tool which has come into the business of road building and upkeep, not only to stay, but to be improved upon, both as to its application and construction. This has already begun to be proven. Indeed, for general purposes, a three blade drag, by covering more longitudinal ground space gives better finish to a road than the two blade. The lever attachment to the steel drag is a good asset, but not, perhaps, essential. Before leaving this subject, however, it is worthy of note to mention the use of the drag upon a gravel road. When run over a hard-surfaced, well knit gravel road it is very harmful to the wearing surface, unless this work is immediately followed up with the roller, to press back into the surface the myriad of minute pebbles which have been either loosened up or dislocated. Where redressing and reshaping of a gravel road is necessary, it is doubtless always better to do this work deftly with the machine rather than with the drag.

In some localities in mountainous or piedmont country, where rock is plentiful and accessible, a rock crusher is a very valuable piece of machinery. And where improved bridge work is being done by convict or free labor this machine is very necessary for crushing the rock to the proper sizes for concrete abutments and arches.

So, too, would it not be amiss to have a pile driver with a hammer weighing from twelve to sixteen hundred pounds, for driving piles in locations where such class of work is expedient.

It is almost needless to mention that barrows, axes, shovels, mattocks, pitch forks, potato rakes, broad axes, cross-cut saws, emery wheels, grindstones, a carpenter's outfit, a small blacksmith's outfit, nails, bolts, washers, repair parts to the machinery, rough repairing material, coils of rope and wire, leather hides, hooks, a supply of dynamite with accessories, an extra harness or two, extra chains of different weights, extra neck-yokes and whiffle trees, one or two small one- and two-horse turning plows, and at least one water wagon, while not the machinery required in county road construction, are certainly very important, if not essential cogs in the machinery to complete an equipment efficient and economical.

To sum up, therefore, road machinery required in county road construction, the following list is suggested:

Wheeled scrapers, of twelve or thirteen cubic feet capacity, known as a No. 2, always equipped with snatch-rods and end-gates, weight about 650 pounds, drag scrapers, of at least 5 cubic feet capacity, known as a No. 2, weight about 85 pounds, back scrapers of the same capacity, two-horse wagons, automatic dump wagons, a six- to eight-horse road machine, a two- to four-horse machine, a four- to six-horse grading plow, weight about 300 pounds, and Rooter plow of about the same weight, a split-log or timber drag, with metal shoes, or steel drag, with or without lever, an eight or ten ton roller, when conditions will justify it, a thirty- or forty-horse power Tractor, and practically all of the accessories above noted.

Finally, as an afterthought, and, perhaps, not of the least moment, the road builder should, by careful study and observation, thoroughly acquaint himself with what tools and road machinery produce the best results under each given condition, and be able to make a practical use of that knowledge by imparting it, when the occasion so demands, to his foremen. He should be able to judge the best constructed machinery and tools, the price sometimes, but not chiefly to be considered. Minutiae of detail of construction of certain machinery is very often a matter of great consideration when facility of operation and durability under hard service is desired; as, for instance, the draft on the team in loading a wheeler, or that of this make of road machine or that. He should be able to know the proper team for given work, and for all the work in general. And, lastly, he should be a good judge of the men best competent to carry on the different phases of the work in hand.

It is possible to make up some statistics on the cost of an equipment such as is outlined above, but this would depend entirely upon the size of the force to be operated, and the amount of funds available for such equipment, based upon the class and extent of work to be undertaken, with a given appropriation.

Road-Surfacing Materials in North Carolina.

BY COLLIER COBB, PROFESSOR OF GEOLOGY, UNIVERSITY OF NORTH CAROLINA.

No State in the Union has a better supply of road-surfacing materials than North Carolina, and each kind is admirably suited to the needs of the section in which it is found. So important is the location of road-making materials in general that many of the excellent European roads shown last night were located with regard to easy accessibility of material for surfacing and maintenance, and we are already finding out in this State that maintenance is every bit as important as the initial construction of our highways.

It is, of course, well known that no kind of surfacing will make a good road where the problem of drainage has been poorly cared for; but where this problem has been solved with success we usually have near at hand all the materials needed for surfacing. It is everywhere recognized that much-traveled roads over which heavy burdens are drawn had best be surfaced with broken stone, while they must not be too hard or too slippery, or too noisy, and as free as possible from mud and dust. Now these conditions demand certain qualities in the stones used, and toughness of material is far more essential than hardness in a road metal, and the cementing and binding power of the material used must be taken into consideration.

Now the igneous rocks, or those that have consolidated from a molten state, possess in a high degree those qualities required in highway construction. Geologists recognize in these rocks two great general groups: the acidic or non-metallic rocks, high in silica, hard and weather-resisting under ordinary conditions, but brittle to the blow of hoofs and of iron-tired wheels; and the basic or metallic rocks, low in silica, and carrying a good percentage of ferro-magnesian minerals, and so exceedingly tough and tenacious that they can hardly be broken with a blow, though regular traffic on the highway grinds from them enough of their substance to serve as an excellent cement.

The acidic rocks are light in weight and light in color, and include the granites and syenites; they are excellent for structural purposes, such as abutments and viaducts and culverts in heavy highway construction, but are too easily pounded to dust, which rain steadily turns into mud, to be of any permanent service as road-surfacing materials. The basic rocks, on the other hand, are heavy in weight and dark in color, and include basalt, diorite, diabase, peridotite, and gabbro, all of which are frequently called *trap* by the engineer, and all having the toughness and cementing qualities requisite in a good road metal.

Trap.—This term is a generally accepted field name for any dark, finely crystalline igneous rock. Trap, or basalt, occurs in long and relatively narrow bodies of rock, which in a state of fusion has forced its way into fissures in older rocks and there chilled and solidified, or it is sometimes found in sheets between the beds or layers of the older rocks, or even in sheets of material poured out on the surface, in the region of our North Carolina brown, red, buff, and gray sandstones, stretching from Granville County on the north entirely across the State and into South Carolina through Anson County. Another exactly similar area extends into the State from Virginia along Dan River reaching as far south and west as Germantown. In these Triassic sandstones, by which name they are known to geologists, the grading of the road bed is relatively an easy task, and nowhere can the right of way traverse so much as a mile without crossing a trap dike. In such a

section we have the ideal conditions for highway construction. Our best macadam roads are all surfaced with this material, the coarser, broken stone being put down first and then filled in and covered with more finely crushed material, and some of these roads have now stood heavy traffic for almost a century. The coming of the automobile into general use has now so modified the problem that some other binder than finely ground trap, well wet down, will have to be found.

In other portions of the up-country and in the mountain regions of the State we have an abundance of basic rock in dikes along every possible highway we could construct, gabbros, diorites, and peridotites, and even granites when fine-grained like the aplites, or where they happen to be free from mica, as the binary granites, may serve as road surfacing materials.

Mica-schist and most metamorphic and crystalline rocks should be scrupulously avoided.

Cherts, or ancient flints, associated with the older limestones of the western part of the State, may render satisfactory service on certain types of road.

Quartzites.—The quartzite found in some of our mountain counties and in portions of Cleveland, Gaston, Lincoln, and Catawba, as well as in parts of Stokes, Forsyth, and Yadkin, are so hard as to be harmful to the hoofs of horses, and so brittle as to become a constant source of fine dust and of mud in wet weather and should be avoided.

Limestones.—The limestones, except when crystalline, make excellent surfacing material for roads carrying light traffic and this is especially true of the shells and shell-rock of our coastal plain region and of some of the magnesian limestones of the piedmont. At several points in the Triassic sandstone areas thin-bedded limestones occur and have been used sparingly with the top dressing to the trap macadam adding greatly to its cementing qualities.

Sand-clay.—The materials for sand-clay surfacing are found throughout the State, and the sand-clay road now promises to be the most satisfactory road we can construct in North Carolina. Good drainage is the first essential to a good sand-clay road, and this should be effected as nearly as possible in the location of the highway. In the sandy stretches of our lowlands, we have but to dig a few feet at farthest to find a substratum of good clay to mix with the sand of the road bed. The ditches dug along the road side to obtain the clay serve the double purpose of draining the right of way and furnishing material for surfacing and should be dug with both these purposes in view. The mixture of the sand and clay should not be made haphazard, but just enough of the clay should be added to the sand to fill its pore space as determined for each section of the road. This can be readily determined by adding to a tumbler of the sand all the water it will absorb, measuring the water carefully as it is added.

Natural Sand-clay.—In many parts of the State a natural mixture of sand and clay exists in the proper proportions; but by *natural sand-clay* is usually meant a decomposed, partially disintegrated granite, of which we have an excellent supply at Chapel Hill. The value of the material depends upon the stage of decomposition attained, and defects may be remedied by the addition of sand or of clay according to the requirements of each case. This natural sand-clay does not make a good roadway for heavy traffic, but it cannot be surpassed for paths and sidewalks.

Lillington Gravel and Lilesville Gravel.—This consists of well rounded

quartz pebbles from the size of a pea to the size of a hen's egg, now extensively used in North Carolina in filters for municipal water supplies and in concrete construction, as well as in surfacing highways. Its best use is in filters, for angular stones serve better in concrete, and stone more angular in form and more basic in composition make a better roadway. Yet there are several stretches of damp, well-shaded roadway in North Carolina, where smaller pebbles have served well to make a good surface, being cemented together by an organic cement like much of the hard-pan or *alots* of The Landes of France and of portions of Florida.

Iron Sands and Ferruginous Hard-pan.—Throughout the sand-hills and coastal plain regions of North Carolina we find occasional beds of sand rich in grains of magnetic iron, and usually where these rest upon a bed of clay the sands or gravels with which they are mixed have become cemented together into an iron-stone affording excellent road-surfacing material. These magnetic sands are so abundant at several places on The Banks that they might even serve for iron ores if smelting facilities were at hand.

Nature has been generous to us with her supplies of road-surfacing materials. Let us make wise use of them.

NOTE—The speaker showed many jars and trays of the several materials from all parts of the State

Lignin Liquor as a Binder for Macadam, Gravel and Sandclay Roads.

BY GEORGE N. MOORE, OF PENNINGTON, NEW JERSEY.

It is generally recognized that macadam construction as a type, is fundamentally correct. But under a concentrated or greatly enlarged traffic, over that of the ordinary, it perhaps, will be conceded that the purely water-bound macadam road has ceased to always meet the tremendous strain of modern traffic.

Nevertheless, despite the broad knowledge of this form of construction had by road builders in general, the real origin of its heretofore entirely efficient bond, has not been generally understood.

Practically all of us thought it was a matter of mechanics and due entirely to the wedging of the stones, brought about in the early days by the compression of traffic, and later by the use of the roller.

That it was due mostly to chemical action was believed, or even thought of, by very few.

This is not surprising, because chemistry is a subtle thing and an understanding of the preferential liking of one atom for another rests mostly with the laboratory man.

As soon as road builders came to realize that plain water-bound macadam would not do, steps were immediately begun to remedy the evil, and, because the chemical theory was mostly hidden in the laboratory, such efforts were pursued entirely along mechanical lines, with the result that in some cases excellent roads were obtained, while in others, the reverse.

I suppose if these results had been uniformly satisfactory that would have ended the matter and it would have rested there for the time being, at least, although, fortunately, the Creator, in His wisdom, has endowed us with two faculties or traits that have made civilized man what he is, and that will, I believe, finally unlock the secret of the universe; they are discontent with things as they may be, and curious to see whether something better can be devised.

This lack of uniformity in results obtained from mechanical bonds set men to thinking, with the result that that chemist was called upon to find out just what it was that caused the cohesion of the macadam road, with the result that he proved beyond dispute that it was really due to chemical action.

He found that the soil water contained certain agents in the way of weak acids, that possessed the ability to dissolve in very small quantities, the silica contained in the stones, doing this as it trickled through the interstices and over the faces of the stones; and that when it dried out it left this deposit with which it was charged between the stones (much as a glass of water charged with salt would leave a deposit on the sides and bottom of the glass when the water has evaporated); and that this deposit so left between the stones constituted a very powerful bond that was insoluble in water, in fact, a union of the stones by a thin film of the stone itself.

In support of this he called attention to the glass that is found on the upper side of every leaf of every tree or plant. As is well known, this glass is in reality, a thin film of stone placed there for the purpose of water-proofing the leaf and preventing it from rotting; and that this stone or silica has been taken from the soil by the tree or plant, the weak acids in the sap of which (this sap being nothing more than soil water) have dissolved, carrying it up and spreading it over the leaf as it develops.

Things were now beginning to move along logical lines and action was governed by pure reasoning—the reasoning that prompts one to make the fire hotter if he wants more steam—with the result that search was made for some means by which the macadam could be strengthened by the production of more of the bond than was within the stone itself and that was not being leached out in sufficient quantities by the action of the soil water to cause the road to withstand the heavy traffic it was being called upon to bear.

The next step was the discovery that the lignin liquor, which is one of the products of paper-making, it being all there was in the tree excepting the wood fibre, contained in small quantities relative to a given bulk, the same weak acids contained in soil water and the sap of the living tree.

The next conclusion was, of course, that if this lignin liquor could be reduced and the acids produced in concentrated form the chemical action would be greatly accelerated and the desired results attained.

The problem had now resolved itself mainly into one of mechanics, but this was soon overcome, with the result that this liquor is now available in commercial quantities.

I have here a very striking illustration of the chemical action of lignin liquor. It is a piece out of a street at Covington, Virginia, and is composed of iron blast furnace slag mixed with about ten per cent of clay.

The lignin liquor has leached the silica out of the slag and so thoroughly mixed it through the clay that the clay has become stone-like and absolutely waterproof.

I have seen pieces similar to this, out of the same road, boiled in water for sixty hours without disintegration or even the slightest discoloration of the water, notwithstanding the presence of the clay.

The clay may be easily identified, especially by noticing the matrices or depressions that have been made in it at points where pieces of slag have rested.

The practice covering the use of lignin liquor is simplicity itself. It needs

no heating nor special apparatus. All that need be done is to place it in any ordinary watering cart, dilute it with more or less water, according to the density of the road, so that it may go down into it and get to work, and then sprinkle it over the surface as though it was plain water.

Lignin liquor is not noxious in any way and it will not injure anything that will stand contact with water.

This means that barriers need not be erected while the application is going on.

I think I should call your attention to the fact that roads treated with lignin liquor may be easily and quickly repaired, resulting in an indefinite prolongation of efficiency.

Sweep out the depression, sprinkle with the liquor, then cast in the road material, again sprinkle with the liquor, and then tamp into place. In a short time the patch cannot be detected from the rest of the road.

There is scarcely any road material on which lignin liquor cannot be used with success, excepting one composed entirely of sand, but where a combination of sand and clay is effected either artificially or naturally (say 80 per cent of sand and 20 per cent of clay), very good results are obtained.

Thomas F. Hickerson, Associate Professor of Civil Engineering, University of North Carolina, Chapel Hill, North Carolina, is authority for the statement in a recent issue of "Better Roads" that experiments in the use of the liquor indicate that sand-clay can be treated just as effectively as water-bound macadam in preventing dust and the destructive action of water on the road.

Professor Hickerson's opinion is probably based upon his observation of the tests made on a road at Chapel Hill by Doctor Pratt.

This road was composed of clay. An up-grade section was selected for the test. In the summer of a certain year (just what year it was I do not recollect, although I was present at the time) about 80 per cent of native sand was mixed with the clay, after which the road was sprinkled with lignin liquor.

The next time I saw this road was in the following winter, the day after a snow-fall had melted away, that winter having been an unusually hard one for this section, at which time, although the road was being subjected to much travel, there was no more ooze on it than would have been on a stone road under similar conditions, while further on, where sand had been mixed with the clay, but the road had not been treated with lignin liquor, it was cut up almost to a depth of a foot; still farther on, where it had neither mixed with sand nor treated with the liquor, it was in a most wretched condition.

Excellent results have been obtained from the use of this liquor on limestone; notably, for instance, on the Chicago road near Laporte, Indiana, and on the roadways around the old hotel at White Sulphur Springs in West Virginia. I have not visited the springs since the building of the new hotel was started and do not know what changes, if any, have been made in the road system there, but my reference is to driveways existing the last time I was there two years ago.

These two roads were old and contained before treatment about an inch of dust. Subjection to the action of the liquor caused this dust to become a part of the roads themselves, making them smooth, hard, and wear resisting. You will note that the dust was not first swept off, as would have been necessary before some binders could have been used. The significance of

this lies in the fact that by the retention of this dust and the making of it again a part of the road, just that much more was added to the life of the road.

The liquor has been found effective in the preservation of roads built of trap rock, and in this connection I think it will suffice to say that the main driveway through the White House grounds at Washington, D. C., is being maintained in pretty good shape by the use of it.

My remarks this morning on the chemical bond would not be complete without some slight reference to the splendid highways along the coast of New Jersey. They are built of clay-gravel, which is a very cheap form of construction, as that material is abundant in that section, and have been brought to a point by the use of lignin liquor where they are as good as any roads anywhere of any construction.

The most celebrated of these highways is probably the boulevard leading from Pleasantville across the Meadows to Atlantic City. It is sixty feet wide, five miles long, and as straight as a tight string. When I tell you that this highway sustains in an entirely satisfactory manner, a traffic amounting to between five and six thousand automobile movements each twenty-four hours during the summer season of about four months, I think you will agree with me when I say in the language of the day, that it is "some road."

It is also interesting to note that the chemical action of lignin liquor makes it possible to use for road building some materials that heretofore have been entirely unfit for such purposes—as, for instance, red shale, than which nothing could be more unsuitable. While this material is abundant and cheap over a wide area in northern New Jersey, it could not be used, because it soon ground up under traffic into a very sticky mud.

Laboratory experiments were carried on, resulting in the conclusion that shale could be made fit by the use of lignin liquor. This laboratory conclusion has been entirely borne out and shown to be correct by the construction of a shale road at Princeton University leading over to Graduate Hall, and then treating it with lignin liquor.

I do not think I err when I say this is the first worth-while shale road ever built in New Jersey. It is smooth, hard, and wear resisting, sheds water quickly, and gives promise of long continued efficiency.

The use of lignin liquor opens wide possibilities in the way of constructing cheap, yet satisfactory highways, by making available local materials not only of value, but that which has been heretofore without value; and my excuse for such constant reference to this liquor is that it is the only medium yet put forward in commercial quantities that will produce the chemical bond which I have endeavored to explain to you this morning.

I have not entered into the question of cost in connection with the use of lignin liquor, for the reason that to do so I would be obliged to make specific comparisons, which, of course, I should not do on this occasion; besides which it is, properly, a question for the manufacturer to answer.

I think, however, it would be within bounds for me to say that roads built with the aid of this material are the cheapest to construct and the cheapest to maintain.

I have gone into this subject in the briefest possible way this morning, but I trust I have created sufficient interest to cause you to look into it further, as I assure you it is entirely worthy of investigation.

There were submitted to the Institute for the consideration of its members, various blanks used by road engineers and superintendents, contract forms, etc. Some of these seem to be of especial interest and are given beyond:

**Form of Contract for Roads Used by Commissioners of Greene County,
Tennessee.**

Proposals for relocating, grading, improving and macadamizing roads in Greene County, Tennessee, as indicated and set forth in the plans and specifications for the work on file in the office of the Greene County Pike Commission, at Greeneville, Tennessee.....

Time and Place of Receiving Bids. Sealed bids or proposals for the above work will be received by the Pike Commissioners of the county of Greene at the office of their engineer in the town of Greeneville, Tenn., until 12 o'clock, noon, At which time and place the bids will be opened, read and compared and a contract may be awarded by the said Pike Commissioners to the lowest responsible bidder as soon thereafter as the said commissioners may elect. The right is reserved by said commission to reject any or all bids, if deemed for the best interest of the county.

Form.—Each proposal for the entire work must be accompanied by a certified check or approved bond for.....dollars, and each bid on any part or section by a check in the sum of.....dollars. The prices must be written in the bids and also stated in figures, and all proposals must be regarded as informal which do not contain bids for all items mentioned in the schedule.

Bids to be Verified.—Bidders are also required to state in their proposals their names and places of residence and the names of all persons interested with them in said proposal. The bid must be verified in writing by the person or persons making the same. If more than one person be interested, it is required that the verifications be made and subscribed to by each.

Award of Contract.—In case the contract shall be awarded to the person or persons making this proposal, he or they shall, within five days after receiving notice from the commission of such award, enter into a contract with the said commission for the performance of the work, as called for by the specifications hereto attached.

Bonds and Sureties.—The contractor shall execute a good and sufficient bond, for 10 per cent of the total estimated cost of the improvement, the same to be approved by the commission, the condition of the bond being that the contract shall be faithfully performed and that the contractors shall pay all sums agreed to be paid for the work done and materials furnished in performance of said contract. The bond shall be signed by the contractor as principal and two or more responsible residents of the State of Tennessee,as sureties, and such sureties, together, shall qualify in amount equal to double the penalty of the bond, over and above all other liabilities which they have incurred. The contractor shall also execute proper bond in such sum as the commission deems proper to pay and satisfy all sums due for material furnished and labor done upon said roads or in connection therewith. A responsible surety company doing business in the State of Tennessee will be acceptable to the commission.

Upon the execution of said bonds, the certified checks shall be returned to the parties bidding on the work. In case such lowest responsible bidder does not make the bonds required and enter into a contract, as above provided, then said certified check shall be forfeited as just and liquidated damages to the county. In case of failure of the lowest responsible bidder to enter into a contract within five days, as provided above, the commission shall have authority to either return the certified checks accompanying the other bids or it may notify the next lowest bidder that his bid will be accepted.

Definition of Engineer.—Whenever in the specifications and in this contract the word "Engineer" is used, it is to be considered as referring to the engineer appointed by the Commissioners of Greene County.

Definition of Contractor.—Whenever the word "Contractor" or words "party of the second part," or the pronoun in the place thereof, are used, they are to be considered as referring to the party or parties of the second part to this contract.

Stakes to be Preserved.—The contractor shall be responsible for the preservation of all stakes, streets or road bounds and bench marks made or established on the line of said work, and, in case they are lost or destroyed, he will be charged with the cost of replacing them.

Right to Change Grade or Plan, or Suspend Work.—The commissioners and engineer reserve the right to make any such and all such changes deemed by them, in their discretion, for the best interests of the county, including the right and power to change the character of the proposed work in material and construction, or otherwise, and to temporarily or permanently suspend or abandon any part of the same. Such suspension or abandonment shall be made only on written order of the commissioners or engineer to the contractor. The contractors agree not to claim damages by reason of delay caused by permanent injunctions or causes beyond human control, but may be granted a corresponding extension of time. But they shall give notice to the commissioners or engineer in writing at time of such delay of any purpose to claim extension of time.

Inspection.—All material and workmanship of any and every kind and description shall be subject to the inspection of the engineer or his assistants. Whenever unfaithful work is discovered, it shall be reconstructed immediately at the expense of the contractor on notice to that effect given by the engineer to the contractor or his agent in charge. And the determination of the engineer as to the unfitness of any material or work, shall be final and conclusive.

Work and Material to Agree With Specifications.—Any material furnished, which, in the opinion of the engineer, shall not be in accordance with these specifications, shall be immediately removed and other material furnished which shall be in accordance therewith and approved by the engineer.

Piling of Material. All material delivered on the street or road shall be neatly and compactly piled in such a manner to cause the least inconvenience to property owners and the general public; all private drives and street crossings shall be kept open. In case the commissioners and engineer order the work suspended, the contractor shall immediately collect and pile all material as specified in the preceding clause.

Obstructing Travel.—Travel on the street, road or any intersecting street or road shall be interfered with as little as possible, and said streets or

roads shall not be closed to travel for a greater period than twenty-four hours without the permission of the engineer. When necessary to do so, the contractor shall provide and set up signs at the nearest cross streets or roads upon each side of such part of the street or road obstructed. And when work is being done upon any traveled road, or whenever the work interferes with travel, suitable passing places will be provided, prepared and maintained by the contractors.

Injury to Property.—In the case of any injury to property by the contractor, which can not be entirely repaired by him, the said contractor shall pay to the owner all damages he or they may suffer thereby. He will, in all cases, be responsible for trespass or damages on the part of himself or employees.

Work to be Prosecuted at Certain Points.—The work shall be commenced at such points, and prosecuted in such a manner, as the engineer may from time to time direct.

The macadam or gravel on any road shall be commenced at the most distant point from the source of supply and hauling over unfinished work shall be restricted as much as possible. No macadam shall be placed on finished road bed until, in the opinion of the engineer, the grade is sufficiently settled to receive it properly, and the engineer may stop work on any given section, when, in his opinion, weather or other conditions are such as to prevent its being done satisfactorily.

Removal of Encumbrances and Rubbish.—All surplus material, of whatever nature, shall be removed from the line of work as the same progresses; any refuse or debris or other material not removed within ten days after the completion of the said work shall be removed by order of the engineer and the amount of the expense thereof shall be paid by the contractor or be deducted out of any money then due or becoming due said contractor.

Safeguards.—The said party of the second part shall be and is hereby required, during the performance of the said work, to place proper guards upon or around the same for prevention of accidents and at night will provide colored lights, if necessary, and shall indemnify, and save harmless the party of the first part, and Greene County, from all suits and actions of every kind and nature brought against it on account of negligence on the part of said contractor, or injuries received during the progress of the work.

The contractor shall take all risks from floods and casualties of every description. Notices given to the person highest in authority in charge on the immediate work shall be binding on the contractor.

Right to Close up Highways.—The right to close up any road and keep the public from using the same during the progress of the work is reserved by the commission. And when said roads are so closed or obstructed the contractor shall provide suitable passings as hereto stipulated.

When Upon Private Property.—The contractor, when at work upon those portions of the road running through private property, shall be governed entirely by provisions named in the deeds of right of way or as directed by the commissioners.

Only Competent Men to be Employed.—And the said part.... of the second part agree that..... will employ only competent, skillful and faithful men to do the work and that whenever the engineer shall inform in writing that any man on the work, in his opinion, is incompetent, unfaithful or is conducting any part of the work contrary to

instructions of said engineer, or his agents are, for any reason, unsatisfactory to the engineer, the contractor will immediately discharge him from the works and will not again employ him thereon.

Persons Designated to Have Access to Work.—The right to build bridges or culverts or lay any pipe or construct necessary appurtenances in connection therewith in said road at any time during the progress of the work is expressly reserved by the commissioners and engineers, as well as suspending the work or any part thereof, or at any time during the construction of the same for the purpose above stated without compensation to the contractor, and the said contractor shall not interfere with or place any impediment in the way of any person or persons who may be employed in the construction of the above stipulated work. The contractor shall, at all times, during the progress of the work, afford the engineer and assistants free and uninterrupted access to the work wherever the same is being prosecuted, and also afford such access to men, animals, wagons, tools and material in order that such agents, employees or contractors may be enabled, without hindrance or delay, to perform any work which, by the terms and conditions of this contract, may be required to be done.

Abandonment or Delay.—The said part..... of the second part further agree.....that if the work under this agreement should be abandoned by the part..... of the second part, or if at any time the engineer should be of the opinion and should so certify in writing that the said work, or any part thereof, is unnecessarily delayed, or that the said contractor is wilfully violating any of the conditions or covenants of this contract or executing the same in bad faith, the commissioners shall have the power to notify the aforesaid contractor to discontinue all work or any part thereof, under this contract, and thereupon said contractor agrees to and will discontinue such work, or any part thereof, and the said commissioners shall have the power to place such and so many persons thereupon to work at and complete the work or such part thereof in such way or manner herein described as they may deem advisable, acting with and under the directions of the engineer, and to use such material as they may find upon the line of said work, and to procure other material for the completion of same, and to charge the expense of said labor and material to the aforesaid contractor, and the expense so charged shall be deducted and paid by the party of the first part out of the money due or which may at any time thereafter become due to said contractor under and by virtue of this agreement or any part thereof, and if in any case such expense shall exceed the sum which would have been due if completed by said contractor, he shall pay the amount of such excess to the party of the first part on notice from the engineer of the excess so due, or be liable therefor upon his bond.

Claims for Work and Material.—The said part..... of the second part further agree that.....will punctually pay the workmen who shall be employed on the aforesaid road, and that.....will, upon the completion of the work, file with the commissioners an affidavit to the effect that all persons who did work or furnished material for the said part..... of the second part under this agreement, have been fully paid or provided for. Said affidavit shall further set forth that all claims for damages against said part..... of the second part or their agents, in the prosecution of the work aforesaid, have been fully paid, or secured. And shall give bond for such payment, as hereinbefore provided.

Not to Sublet.—And the said part.... of the second part further agree that..... will give..... personal attention constantly to the faithful prosecution of said work and that..... will not assign or sub-let the same without the consent of the part.... of the first part, but keep the same under..... control.

Contractors Using Materials.—The contractor shall get all material for use upon the road, of whatever kind or nature, from such location only as directed by the engineer and when at work on the improvements through private property he shall only use materials from off adjacent lands, when and where directed by the commissioners or engineer.

Commencement of the Work.—The part.... of the second part further agree that..... will begin the aforesaid work within..... days after the execution of this contract, at such place or places as the engineer and commissioners may designate and progress therewith from said place or places so as to complete the same in accordance with this agreement on or before the..... day of.....

Engineer's Estimate.—The said part.... of the second part further agree that the return or report of the engineer in charge of the work shall be the account by which the amount of the materials furnished and work done shall be computed.

Engineer's Certificate.—The certificate of the engineer in charge, that the work has been faithfully performed in accordance with the requirements of this contract and the specifications herein contained, shall be a condition precedent to the right of the said part.... of the second part to receive payment due..... under this agreement for the work or any part thereof.

Monthly Payments.—Monthly payments, if desired, shall be made upon the proper certificate from the engineer in charge to the extent of 90 per cent of the value of the work done at the time, as estimated by the engineer. Payments to be made on the fifteenth (15) of each calendar month for the work done and material furnished during the previous month.

Certificate of Completion.—Upon the completion of the work embraced in this agreement the engineer shall file with the commissioners a certificate stating the fact of the proper completion of the contract.

Final Payment.—The contractor shall satisfy the commissioners by proper receipts from all parties furnishing material and performing labor, that the same has been fully paid or provided for before he shall be entitled to receive the contract price in full. And the party of the first part hereby agrees, upon completion of the work, and receipt of the engineer's certificate, to pay the said part.... of the second part the balance then due said contractor. But this right to the reserved per cent shall only accrue when the entire contract of the second party is complete; and not upon the completion of each road, or distinct part of the work.

Extra Work.—It is expressly understood that the said part.... of the second part shall not receive payment for any extra work of any kind or nature, unless the same shall be ordered by the chief engineer in writing; and the claim therefor presented at the first monthly payment thereafter, and no work will be deemed extra that is capable of being measured, computed or estimated under these specifications.

Interpretation of Specifications.—In case of ambiguity of expression in the specifications, or doubt as to the correct interpretation of the same, the

matter shall be submitted to the chief engineer, whose decision shall be final and binding on both parties.

GENERAL SPECIFICATIONS.

Clearing and Grubbing.—The whole of the right of way or ground acquired or set apart for the road shall be cleared of all trees, brush or other perishable matter which shall be burned or removed from the entire face of the ground to be occupied or set apart for the right of way in such a manner as not to damage adjoining lands, crops or fences or disturb the engineer's stakes. But if there be any timber on the right of way of merchantable quality it shall not be burned or destroyed but cut in such lengths as may be designated by the engineer and placed in a convenient place for removal by the commissioners or their agents without extra compensation, it being a part of the work of clearing.

Trees, saplings and brush shall be cut close to the ground. All stumps shall be grubbed from slopes of cuts, from ditches, from new channels for waterways and elsewhere on the right of way, if required.

Clearing and grubbing shall, in all cases, be kept 500 feet ahead of grading, and a separate price shall be fixed for each, per acre actually cleared or grubbed. No payment shall be made for removing grass, weeds, briars, small bushes, fences or growing crops from the right of way or road bed.

Where no estimate is made of clearing and grubbing in the engineer's approximate, the prices bid for excavation must include all clearing and grubbing and no bid will be considered on such section or road.

GRADING.

Grading.—Under this general head will be included excavations and embankments required for the formation of the road bed, or in any way connected with, or incident to the construction or drainage of the same, or the change or crossing of roads and streams.

All grading shall be done and estimated by the cubic yard, measured in excavation and paid for as excavation only.

The road will be graded with such widths, depths and slopes of cutting and filling as the engineer may determine; and such ditches shall be dug within or without the limits of the road as directed.

Excavation.—The road bed shall be of such width and cross section as the engineer may direct from time to time, as the work progresses.

All excavation and grading must be done in strict accordance with the line and grade stakes; all crests shall be neatly finished, and slopes shall be true and straight and of such inclination as may be indicated from time to time by the engineer.

The road bed shall be surfaced smoothly to conform to grade stakes, and side ditches shall be excavated to the depth and cross section indicated by the engineer. Excavation for ditches, for change of channels of streams, for change of roads or approaches, for foundation for masonry, and excavation of any kind which may be required for the construction of the road, shall be done well and in conformity with the grades, locations and cross sections which may thereafter be determined and fixed by the engineer.

All material that may slide from the sides of cutting, if the slides are attributable, in the opinion of the engineer, to the carelessness or negligence

of the contractor, shall be removed by the contractor at his own cost, to such place as the engineer may direct.

All excavations shall be done and estimated by the cubic yard, measured in excavation and paid for as excavation only.

Material excavated from without the slope line shall be at contractor's loss.

Excavation shall be classed under the following heads, viz.: Earth, Loose Rock, and Solid Rock.

Earth shall include loam, clay, sand, chert, cemented sand, indurated clay, joint clay, pipe clay, decomposed rock and shale, and all other material of an earthy kind. Earth shall also include loose stone or boulders which do not exceed two (2) cubic feet in size, inclosed in masses of earth wherein the proportions of boulders or loose stone is one-half ($\frac{1}{2}$) or less.

Loose Rock shall include hard shale, slate, soft friable sandstone, cemented gravel, or conglomerated rock, stratified stone in layers of six (6) inches or less, masses of boulders or detached rocks, free from earth in which the average size of boulders or detached rocks is not less than one (1) cubic foot, nor more than one (1) cubic yard; masses of earth mixed with loose stone and boulders of one (1) cubic foot or more average size, wherein the proportion of rock to the whole mass is more than one-half ($\frac{1}{2}$).

Solid Rock will include all rock in place, which rings under the hammer in masses of more than one (1) cubic yard with the exception of stratified stone described in the specification for loose rock.

Rock Cuts shall be excavated below grade, and afterwards filled to grade with small stone or such other material as the engineer may designate and payment shall be made for excavation to a depth of one-half ($\frac{1}{2}$) foot below grade, but no payment shall be made for refilling to grade.

Haul.—All material from excavations, except when otherwise directed by the engineer, shall be deposited in the embankments. The cost of hauling and depositing or placing excavated materials in embankments, when the average haul is not more than five hundred (500) feet, shall be considered as paid for in the price paid for excavation.

Extra haul of one cent (1) per cubic yard shall be estimated and paid for as follows: Whenever material from any cut is necessarily hauled a greater distance than five hundred (500) feet, there shall be paid in addition to the price of excavation the price of extra haul per one hundred (100) feet for each one hundred (100) of average haul in excess of an average haul of five hundred (500) feet. Fractional parts of one hundred (100) feet of extra haul shall be paid for at a proportional rate.

Average haul shall be computed for each cut separately, and short haul from one cut shall not offset long haul from another cut. The average haul from one cut shall be the distance between the center of gravity of that portion of the cut hauled and center of gravity of the fill which the material hauled from that cut makes.

Drain Pipe.—Where bids are called for on pipe for waterways hauled and laid complete, it is to be understood the commissioners are to furnish f. o. b. cars at most convenient point to work, the contractors to unload the same in a careful and prudent manner at place to be furnished by the commissioners.

Where bids are called for on pipe for waterways furnished and laid complete, it is to be understood that all pipe so furnished by the contractor is subject to inspection by the engineer and must be of an approved quality.

Masonry.—All masonry will be estimated and paid for by the cubic yard and will be included under the following heads, viz.: *Second Class Masonry, Third Class Masonry, Box Culvert Masonry, Rip-Rap, Paving, Concrete Masonry.*

Second Class Masonry will be rock-ranged work of the best description to be laid in cement mortar as the engineer may direct, the stone to be of the best and hardest quality which, in the judgment of the engineer, will not disintegrate or split from exposure to the weather. All face stone shall be accurately cut and lined and laid in courses not less than twelve (12) inches thick, and decreasing from bottom to top of the walls, the joints to be well broken—no break to be less than nine (9) inches. No joint to be laid more than three-fourths ($\frac{3}{4}$) of an inch. All stretchers shall have at least as much bed as rise and shall hold the face size at least nine inches back into the wall on both upper and lower beds. All headers shall have at least twice as much bed as rise and shall hold the face size at least two feet back into the wall. Headers shall occupy at least one-fourth of the wall. No header shall show on the face less size than the thickness of the course in which it is laid. All backing shall be laid with the largest stone practicable and thoroughly grouted. The backing stone shall always be cut down to the level of the course before it is set. No spawls shall be used as levelers.

Third Class Masonry will be of the best description of uncoursed masonry to be laid in cement as the engineer may direct; to be built of stones not less than eight inches thick, to have horizontal beds and vertical joints on the face. Vertical joints of the face to be not less than eight (8) inches from the face, and as much more as the stone will work. No joint to be laid more than three-fourths ($\frac{3}{4}$) of an inch. The stretchers and headers to be not less than two (2) feet long; to have beds not less than fifteen (15) inches wide and always at least as wide as high. At least one-fourth of the whole number of stones in the face of the wall to be headers and arranged so as to distribute them as equally as practicable over the whole face. The headers shall run through the wall, or interlock, or be connected in the heart of it. The backing stones shall be of similar general dimensions and proportions as the face stones with equally good beds and bond. No spawls shall be used as levelers.

Box Culvert Masonry will be laid in cement mortar. The side walls shall be built of good-sized and well shaped stones properly laid and bound together in each course by stones extending entirely through the wall, at least every six feet in length of the wall. Headers and stretchers shall not be less than fifteen (15) inches wide and at least as wide as high. The back of walls to be built the same as the front, with the exception of the facing. The upper course to have at least one-half ($\frac{1}{2}$) of the stone headers and its stretchers in no case less than fifteen (15) inches wide; no stone in this course to be laid less than six (6) inches thick. The covering stones to be sound and strong and of such shapes as to form suitable joints; to be approved thickness according to width of opening, but in no case less than eight (8) inches thick and to lie with their whole width not less than twelve (12) inches on each side wall. Care will be taken to show a neat finish at the ends of the culvert.

Rip-Rap shall consist of stone placed as the engineer may direct for the protection of masonry or earthwork.

Paving shall be made by setting stones from eight (8) to twelve (12) inches in depth on edge breaking joints as directed by the engineer.

General.—The ends of the pipe shall be protected in such manner as may be directed by the engineer.

The hammering or dressing of stones upon a wall where cement is being used is expressly forbidden; and the stones must be lowered into place so as to not disturb those previously laid.

All stones for different classes of masonry must be furnished from the best quarries in the community where the work is done.

All masonry to be estimated and paid for by the cubic yard; and the number of cubic yards to be paid for shall be the actual solidity thereof, by strict mathematical calculation—any vacant space or spaces that may have been left therein in accordance with the plans and specifications of the work and requirements of the engineer being excluded; and no double measurement of any part or parts of said masonry being allowed, any rule or custom as to the mode of measurements to the contrary notwithstanding.

The price per cubic yard of masonry will include the cost of furnishing all materials; it will also include the cost of foundations, pumping, bailing, scaffolding and all other expenses necessary to the construction and the completion of the masonry according to the plans, in all cases in which it is not provided by these specifications that it shall be otherwise; and the contractor shall be at all risks from water and casualties.

Cement mortar in all classes of masonry must be made of one part of good Portland cement and two parts of clean, sharp sand, well mixed together with clean water, in clean mortar beds constructed of boards, and must be used immediately after being mixed.

Sand for mortar must be washed if not clean enough to be used otherwise.

All classes of masonry laid in cement must be neatly pointed with cement mortar finely tempered.

The foundation courses for all classes of masonry must be large selected stones.

No masonry of any kind will be covered up before being accepted by the engineer.

Foundations for masonry shall be excavated to such depth as to secure a safe and solid foundation of which the engineer shall judge; the materials excavated to be measured, classified and paid for at the rates provided for like materials in grading.

When a safe and solid foundation can not be procured at a reasonable depth, there shall be prepared by the contractor such artificial foundation of timber, piling, crib work or concrete, or either in combination with concrete, as the engineer may direct.

Timber used in foundations, bridges or otherwise, shall be sound white oak, or such other suitable timber as the engineer may approve. It will be paid for per thousand feet board measure, the price to cover material, framing and putting in place. The engineer shall determine the size, shape, manner of framing and placing all timber used in foundations.

Concrete.—Concrete must be composed of one part of best quality Portland cement, approved by the engineer, two and one-half parts of clean, sharp sand, and five parts of clean, sound, durable limestone, dust removed, or other sound stone acceptable to the engineer, and so broken as to pass through a two inch ring.

Concrete shall be mixed in a batch mixer of approved design, or if in small quantity may be mixed by hand in a manner to be decided by the engineer.

At all times the mixing and placing of concrete shall be under the direction of a competent inspector and shall be placed in a careful and workmanlike manner.

The necessary forms for concrete shall be furnished by the contractor, prices for concrete to include cost of same, and where surfaces are exposed the lumber to be used shall be dressed and jointed and the surface of the concrete shall present a neat and smooth surface when forms are removed, no forms to be removed from concrete until, in the opinion of the engineer, it has become sufficiently hardened. Reinforcement of iron shall be used where required by the engineer, in such manner as he may direct.

Location of Drains.—In locations where but a small quantity of water passes, drain pipe may be substituted for culverts as may be directed by the engineer.

Specifications for Macadamizing.—The work to be done under this specification will consist in laying a finished roadway in accordance with plans and specifications. The width of the macadam on all roads shall hereafter be determined by the Pike Commissioners or the engineer, and they shall have the right to change the width and depth at their option.

Where bids are called for, macadam or gravel by the cubic yard, it is understood that the broken stone or gravel shall be delivered in carts or wagons holding one (1) cubic yard or multiples thereof, measurements and accounting for same shall be at the point of spreading, the price to include, preparing the subgrade, shouldering same, quarrying stone, crushing, loading, hauling, spreading, watering and rolling same.

Sub-Foundation.—When the excavation and embankments have been brought to a proper depth below the intended surface of the roadway, the cross section thereof conforming in every respect to the cross section of the road when finished, the same shall be rolled with a ten ton roller until the surface is thoroughly compacted. If any depressions form under such rolling, owing to improper material or vegetable matter, the same shall be removed and good earth substituted, and the whole re-rolled until thoroughly solid and to grade. Whenever, in the opinion of the engineer, the sub-grade is in proper shape to receive the macadam, the contractor will be required to maintain at his own expense until the macadam is put on; on all roads which have been graded by former commissioners the contractor will be paid for dressing and re-surfacing as directed by the commissioners and engineer.

Banking.—Contractors shall procure dirt for banking from ditches and cuts, but not from embankment, and place same outside and against boards flush with top of loose stone and gradually sloping towards ditches as directed by engineer.

First Course of Broken Stone.—After the road bed has been formed and rolled, as above specified, and has passed the inspection of the engineer, the first layer of broken stone, consisting of stone ranging from three (3) inches to one and one-half ($1\frac{1}{2}$) inches in size, shall be deposited in a uniform layer and rolled repeatedly with ten ton roller until compacted to the satisfaction of the engineer, beginning at the edges and working towards the center.

The depth of loose stone in this and all other courses should be measured by blocks the required thickness of the said loose stones.

These blocks must be placed at frequent intervals amid the loose stone when being spread. The compacted stone in this course must be four (4) inches in thickness, or of such thickness as the engineer may direct.

If the stone in this lower course creeps ahead of the roller, and will not compact properly, the stone shall be sprinkled ahead of the roller or a small quantity of stone screenings, or earth, be placed over the surfaces until the stones cease to sink or creep in front of the roller, and is, in the judgment of the engineer, hard, firm and compact.

Second Course of Broken Stone.—The second course of broken stone shall consist of two (2) inches, after compacting, of a stone ranging from three-fourths ($\frac{3}{4}$) inch to one and one-half ($1\frac{1}{2}$) inch. This course shall be spread in a uniform layer in depth and rolled until thoroughly settled in place. Water may be applied ahead of the roller in this course.

Surface.—When the two courses are rolled to the satisfaction of the engineer, stone screenings ranging from three-fourths ($\frac{3}{4}$) inch to dust, or otherwise if directed by the engineer, shall be applied in a thin coat over the surface of the road and shall then be thoroughly wet with a street sprinkler ahead of the roller with the object in view of flushing as much as possible of the screenings into the interstices of the second course, the operation being repeated, more screenings being added, wet down and rolled until the water stands on the surface instead of penetrating, and the screenings entirely cover the second course of stone.

The contractor will be required to use such screens as, in the opinion of the engineer, will give most satisfactory results.

Gutters and ditches shall be constructed on the lines and to the depth and width indicated by the engineer, and the same to be paid for as excavations at the price per cubic yard named in contract. They shall be constructed in a practical manner as directed by the engineer. The ditches shall be excavated to the special width and depth and to the slope as required.

Ditches shall be shaped and cleaned up, all excess material be removed, and the shoulders rolled hard and firm and level with the surface of the roadway, after the broken stone has been completely rolled in place.

The road surface and ditches shall be maintained by the contractor until the whole road shall have been accepted.

SPECIFICATIONS FOR GRAVEL ROAD.

Sub-Foundation.—Sub-foundation shall be prepared in the identical manner specified for broken stone macadam.

Shouldering.—Shouldering is to be provided as specified for broken stone macadam. These shoulders should be at least six (6) inches high to retain the material while it is being placed.

General.—The engineer may stop any portion of the work if, in his opinion, the weather is such as to prevent the work being done in a satisfactory manner.

The contractor is expressly forbidden from putting down macadam or gravel while road bed is too soft from rain or other causes, and the commissioners or their representatives shall always be the judge of this.

The water used by the contractor for sprinkling shall be secured and put on the road at his own expense, the engineer to be the judge of the time, manner and amount of sprinkling. No macadam shall be put down during extreme cold or freezing weather.

The commissioners will furnish an inspector to receive, measure and give a ticket for each cubic yard of crushed stone or gravel delivered at the place of spreading, said tickets to be paid monthly at contract price. The measurements of all crushed stone or gravel shall be at place of spreading.

When received by the engineer, surface ditches shall be cut on top of the slope of excavation and at foot of the slope of such dimension and grades as he may direct, same to be paid for as excavation.

Where it becomes necessary to create borrow pits, same must be staked out by the engineer previous to opening same. Care must be taken to keep such borrow pits a uniform and regular size admitting of proper measurements.

All materials used for the construction of road, whether dirt, stone or gravel, shall be taken from such location as directed by the commissioners or engineer.

Stone for Repair.—Crushed stone shall be delivered at any point designated by the engineer, and dumped along, by or near the road bed for repairing purposes.

Time Allowed for Completion.—The time allowed the contractors in which to complete the entire work on this section will be.....months from the signing of this contract.

Strict Adherence to the Specifications.—Bidders are informed that the engineer will allow no deviations from the specifications, except upon his written order.

The contractors will be required to complete the whole work to the satisfaction of the commissioners, and the engineer, and in accordance with the plans and specifications hereto annexed.

Plans, profiles and specifications may be examined and further information obtained at the engineer's office.

Form of Contract Used by Orange County Good Roads Commission.

ORANGE COUNTY GOOD ROADS COMMISSION.

HIGHWAY IMPROVEMENT.

INSTRUCTIONS TO BIDDERS, CONTRACT, AND SPECIFICATIONS.

CONTRACT AND SPECIFICATIONS.

For Clearing and Grubbing, and Grading, the.....
Sections of the County Road Between.....
and....., Orange County, North Carolina.

INFORMATION TO BIDDERS.

1. Bids shall be enclosed in plain envelope marked in upper left-hand corner "Sealed Bid," and bearing the following address:
 S. Strudwick, Chmn. Orange County Good Roads Commission, Hillsboro, North Carolina.
2. The bids must be signed by the individual members of a firm or company making bids and bear also the legal signature of the firm or company.
3. Prices must be given in both writing and figures, and in the order in which they appear in the list of estimated quantities.
4. Bids must be accompanied by a certified check to the amount of one hundred (\$100) dollars for each section or portion thereof on which the bid

is made. This check is to be made payable to the Orange County Good Roads Commission and is to be returned to the bidder if he properly executes this contract within fifteen (15) days after notice by the Commission of the acceptance of his bid. If the bidder fail to execute this contract within fifteen days after such notice then this check shall become the property of the Orange County Good Roads Commission absolutely.

5. Before the contract is awarded the bidder shall furnish satisfactory bond in a surety company approved by the Commission in the sum of fifty (50) per cent of the amount of the bid for the faithful performance of the work, and for its completion within the time agreed upon.

6. The Commission reserves the right to reject any and all bids and to re-advertise for bids or to have the work done by the county forces.

7. The work is divided into sections of six thousand (6,000) feet each, beginning and numbered consecutively 1, 2, 3, etc.

8. Separate bids must be made for each section; but single bids for sections will be received, provided they are accompanied by separate bids for each section.

9. Separate bids must be made for each of the following classes of work: 1. Clearing and Grubbing; 2. Grading; 3. Draining. Single bids for all three classes will be received, provided they are accompanied by separate bids for each class.

10. The estimated quantities given herewith are approximate only and are given as the basis upon which all bids are to be compared.

11. Copies of the plans and profiles, etc., may be seen at the office of S. Strudwick, Chmn., Hillsboro, N. C., or at the office of M. H. Stacy, Sec., Chapel Hill, N. C.

ESTIMATED QUANTITIES.

Section No.....

<i>Clearing.</i>		Price Bid.
Light (average of fewer than five trees one ft. in diameter to the hundred lin. ft. of right of way).....	acres,	.....
Heavy (average of more than five trees over one ft. in diameter to the hundred lin. ft. of right of way).....	acres,	.....
<i>Excavation.</i>		
Earth	cu. yds.	.....
Loose Rock .....	" "	.....
Ledge Rock .....	" "	.....
Borrowed Material .....	" "	.....
Overhaul	yd. ft.	.....
<i>Concrete.</i>		
Foundations	cu. yds.	.....
Headwalls .....	" "	.....
Small Culverts .....	" "	.....
Reinforced .....	" "	.....
<i>Vitrified Pipe.</i>		
12-inch	lin. ft.	.....
15-inch .....	" "	.....
18-inch .....	" "	.....
24-inch .....	" "	.....

Corrugated Iron Pipe.

12-inch	lin.	ft.	.....
16-inch .....	"	"	.....
20-inch .....	"	"	.....
24-inch .....	"	"	.....
30-inch .....	"	"	.....
36-inch .....	"	"	.....
42-inch .....	"	"	.....
48-inch .....	"	"	.....

Rubble Masonry.

Foundations and Paving.....	cu.	yds.	.....
Headwalls .....	"	"	.....
Culverts .....	"	"	.....

CONTRACT.

STATE OF NORTH CAROLINA,

COUNTY OF ORANGE.

This contract for Clearing and Grubbing, Grading, Draining the..... sections of the county road between.....and..... in Orange County, made and concluded this the....day of....., 19..., between the Good Roads Commission of Orange County, party of the first part, and operating under the name of..... party of the second part.

Witnesseth: That in consideration of the sums hereinafter mentioned to be paid by the party of the first part, and the penalty expressed in the bond of even date with this contract and annexed hereto, the party of the second part hereby agrees with the party of the first part, at their own proper expense, to do all the work and furnish all the material necessary to clear and grub, grade, and drain the.....sections of the county road between..... and....., in Orange County, in accordance with the plans and specifications attached hereto, and signed by the Chairman and Secretary of the Commission and the Highway Superintendent, with such detailed directions and drawings as may be given by the Engineer during construction, and in full compliance with the terms of this contract.

Plans, Profiles, and Specifications.—The plans, profiles, and specifications are hereby made a part of this contract, and will be held to cover any and all work that can reasonably be understood to be required for a complete and workmanlike job. It is understood that no advantage will be taken of any discrepancy that may occur in the drawings or any ambiguity that may exist in the specifications.

Disputes.—If any doubt or dispute arise as to the proper interpretation of the plans, specifications, or contract the complaint shall be made to the Engineer in writing and shall be decided by him.

Changes in Plan.—The right is reserved to make any changes in alignment, grade, or cross sections that may seem advisable to the Engineer, provided

that payment to the Contractors shall be increased or diminished in proportion as the amount of labor is increased or diminished. In case additional material is required by the change it shall be paid for at the price made in the bid.

Contractor's Liability.—The Contractors shall be responsible for all risks, accidents and damages to persons or property that may occur during prosecution of the work by reason of negligence or carelessness on the part of the Contractors, their agents, or employees.

Subletting Contracts.—The Contractors agree to give their personal attention to the work embraced by this contract, and not to sublet the same, or any portion of it, without the written consent of the Commission. In case subletting is permitted the parties of the second part, herein named, shall be held fully responsible for the satisfactory completion of the work.

Instruction to Foreman.—The superintendents or foremen of any particular portion of the work shall receive and obey instructions from the Engineer in case the Contractors are not themselves present.

Beginning and Completion of the Work.—This work is to be begun within days after the execution of this contract, and is to be diligently pushed to completion in such order as may be prescribed by the Commission.

The Contractors hereby agree to complete the work on or before....., and should they fail to complete the work on said date, then they shall forfeit the sum of ten (\$10) dollars on each section unfinished for each and every day thereafter until the work is completed.

The Commission hereby agrees to close to traffic the sections upon which work is being done if requested to do so by the Contractors.

Bond for Performance of Work.—Before this contract is executed the Contractors shall furnish bond in the sum of fifty (50) per cent of the amount of their bid for the faithful and diligent performance of the contract and for the completion of the work in accordance with the above conditions. This bond must be in a reliable Surety Company and must meet the approval of the commission.

Removal of Rejected Work.—The Contractors shall immediately remove and reconstruct, at their own expense, all work not done in accordance with this contract, and failure of the Engineer to disapprove of any work at or before the monthly estimate, or any time before the final completion and acceptance of the entire work, shall not constitute an acceptance, notwithstanding the materials and work may have been estimated and paid for.

Abrogation of Contract.—The following causes shall, at the option of the Commission, constitute an abrogation of this contract: 1. Failure on part of the Contractors to perform the work according to the terms of the contract; 2. Abandonment of work for more than fifteen (15) days continuously unless prevented by an act of Providence.

Completion of Work in Case of Default.—If the Contractors abandon the work or otherwise default in the performance thereof the Commission shall have the work completed by such other means as it sees fit, and the total cost of completion shall be borne by the defaulting Contractors.

In case the Contractors default in the performance of the work, no equipment nor material belonging to them and situated on the work shall be removed without the written consent of the Commission. Such material and equipment shall, if required by the Commission, be used in completing the work.

Laws and Ordinances.—The Contractors and their agents shall so conduct the work as to fulfill all the requirements of State, county, and town laws and ordinances that apply to the work, and shall take all reasonable precautions to guard against accident and loss of life.

Incompetent and Disorderly Persons.—Should any person employed by the Contractors show evidence of incompetence or behave disorderly he shall be immediately discharged on request from the Engineer, and shall not be again employed on the work without the consent of the Engineer.

Definitions.—Where the word "Commission" is used in this contract it shall be understood to mean the Good Roads Commission of Orange County, party of the first part to this contract, or their authorized representatives limited to the particular duties entrusted to them.

Where the word "Contractors" is used it shall be understood to mean, parties of the second part to this contract, or their authorized representatives.

Where the word "Engineer" is used it shall be understood to mean the Highway Superintendent of Orange County, or his authorized representative limited to the particular duties detailed to him.

Where the words "satisfactory to," "as ordered," "as permitted," "accepted," etc., they shall be understood to mean satisfactory to, as ordered by, as permitted by, accepted by, the Commission or its authorized representative.

Payments.—Payments shall be made by the Commission to the Contractors as follows:

On monthly estimates furnished by the Engineer, ninety (90) per cent due on said estimates; ten per cent to be retained until a section is completed, when the whole amount due on that section will be paid on certificate from the Engineer that the work on that section has been completed in accordance with the specifications and contract. All partial estimates and partial payments shall be corrected in the final estimate and final payment.

In accordance with the foregoing, the Orange County Good Roads Commissioners, party of the first part, agrees to pay, party of the second part, for work done, at the rates and prices set forth by the party of the second part in the lists of estimated quantities under the heading "Price Bid."

Section	Clearing and Grubbing.	Grading.	Draining.
1 . . .	\$.....	\$.....	\$.....
2 . . .	\$.....	\$.....	\$.....
3 . . .	\$.....	\$.....	\$.....
4 . . .	\$.....	\$.....	\$.....
5 . . .	\$.....	\$.....	\$.....
6 . . .	\$.....	\$.....	\$.....
7 . . .	\$.....	\$.....	\$.....
8 . . .	\$.....	\$.....	\$.....
9 . . .	\$.....	\$.....	\$.....
10 . . .	\$.....	\$.....	\$.....
11 . . .	\$.....	\$.....	\$.....
12 . . .	\$.....	\$.....	\$.....
Total . . .	\$.....	\$.....	\$.....

Contract to be Read and Understood.—The Contractors hereby agree that they have read every clause in the contract and have examined the plans, profiles, and specifications, and that they understand the same and will comply with all the terms thereof.

This contract is to be executed in triplicate, one copy to be retained by the Commission, one furnished the Contractors, and one to the Engineer.

Further Agreements.

.....

In witness whereof, we, the parties to these presents, have hereunto set our hands and seals, this the day and year first above written.

.....

 Good Roads Commission of Orange County.

.....

 Contractors.

Signed in the presence of:

.....

SPECIFICATIONS.

Work to be Done.—The Contractors are to furnish all equipment, labor, and material required for the clearing, grubbing, draining and grading of the road above designated in accordance with the accompanying plans and specifications under the inspection and jurisdiction of the Engineer. Said plans and specifications are to be signed by the Chairman and the Secretary of the Good Roads Commission and by the Highway Engineer.

The Contractors are to leave the road and the immediate vicinity in a neat, presentable condition and ready for surfacing.

Clearing and Grubbing.—The right of way shall be cleared to a width of twenty (20) feet on each side of the center line, unless otherwise specified by the Engineer; all trees, bushes and brush within the space designated to be cut down and removed to the adjoining land and the brush burned, as the Engineer may direct.

Within the space included by the slope stakes all roots, stumps and timbers imbedded in the ground shall be grubbed out or removed by a stump-puller, except where they will be covered by a fill two and one-half feet or more in height, in which case they may be cut off at the surface of the ground

All other timber on the right of way shall be cut close to the ground or pulled or grubbed.

Earthwork.—The roadbed shall be graded to the grades, widths, and shapes shown by the accompanying plans, profiles, and cross sections, which are a part of these specifications.

Excavation.—Under the head of excavation shall be included all excavation required for the formation of the roadbed, cutting drainage ditches, cutting new channels for streams, cutting all necessary approaches for intersecting roads, and all excavation necessary to the proper construction of the road, including the hauling and depositing of the material in embankments wherever required by the Engineer, excepting that all material required to be hauled more than six hundred (600) feet shall be classed as overhaul and shall be paid for according to contract.

All grading shall be done and paid for by the cubic yard measured in excavation unless a bid be accepted for a certain amount per mile, in which case there will be no extra charge for overhaul nor for borrowed material.

No material shall be borrowed except when the amount excavated from the roadbed in one thousand (1,000) feet in each direction from the place of deposit is insufficient to make the required embankment, unless it is specially authorized by the Engineer. Nor will payment be made for borrowed material if an equivalent amount be wasted within one thousand (1,000) feet on either side of the place of deposit, unless the material wasted is unfit for use in the embankment and is ordered wasted.

Borrow Pits.—Where borrow pits are necessary they shall be staked off by the Engineer, and on completion shall be dressed up to a uniform surface and grade so as to drain off the water.

Classification of Material.—All excavation shall be classed under the following heads: 1. Earth; 2. Loose Rock; 3. Ledge Rock.

Earth shall include all material that can reasonably be plowed and that does not come under the classification of loose rock.

Loose Rock shall include all stone found in separate pieces containing more than one cubic foot and less than six cubic feet, and all shale and slate loose enough to be removed without blasting.

Ledge Rock shall include all rock and boulders over six cubic feet in volume which requires blasting for its removal.

No unsightly piles of rock or rubbish of any sort shall be left within the right of way by the Contractors when they have finished.

Embankments.—Embankments shall be formed of earth, gravel, or rock. They shall not contain loose vegetable matter nor refuse matter of any kind. When sod is placed in embankments it shall be placed near the edges and at least two feet below the finished surface, otherwise it shall be wasted.

Embankments shall be formed in layers approximately one foot in depth, and the material shall be spread as dumped by allowing the scrapers to turn over gradually instead of dumping in heaps.

When an embankment is formed of rock the rock shall be carefully placed and the spaces filled with earth or gravel.

Drainage.—Under the head of drainage is included all tile drains necessary for draining the subgrade, all cross-over drains of whatever character, all waterways that shall be classed by the Engineer as culverts, whether of pipe, concrete, stone, or steel and concrete, and all paving of waterways and channels leading to and from the same.

Where required by the Engineer, catch basins shall be constructed at the entrance to culverts, and the outlets shall be paved or otherwise protected from undermining, as the Engineer may direct.

Culverts.—Culverts shall be built of one of the following materials: 1. Stone; 2. Vitrified pipe; 3. Corrugated pure iron pipe; 4. Concrete. Their location, length, area of waterway, and type shall be as directed by the Engineer.

Stone.—The use of rubble masonry will be allowed for culverts up to spans of four feet. The bottom shall be paved with stone to a depth of not less than ten inches, and the arch shall have a thickness of at least one foot. The stone shall be laid in good cement mortar of the proportions 1:2½.

Vitrified Pipe will be allowed for culverts only when the earth covering will be two or more feet. The pipe shall be of good quality, well burned and free from cracks, and shall have well-formed bells.

The pipe shall be laid to a uniform grade of not less than one-fourth inch to the foot. Both inlet and outlet ends shall be protected by headwalls of concrete or stone laid in cement mortar of proportions 1:2½. The backfilling shall be carefully tamped in and no rocks will be allowed to touch the pipe.

Corrugated Iron.—Where corrugated iron is used for culverts it shall be of a quality and gauge satisfactory to the Engineer. The specifications as to alignment, grade, headwalls, and manner of laying are the same as for vitrified pipe.

Concrete.—Concrete for culverts shall be composed of a good grade of Portland cement, which will meet the specifications for same, hereinafter given, clean, sharp sand, and crushed stone or gravel in the proportions 1:2½:5 for small culverts, 1:2:4 for reinforced culverts, and 1:3:6 for foundations.

The concrete shall be thoroughly mixed and spaded into the forms, the coarse material being pressed away from the forms to allow a smooth surface of the finer material to be formed. The culverts shall be built to the dimensions given by the Engineer, and, unless otherwise specified, the details shall be those given in Economic Paper No. 28 of the North Carolina Geological Survey.

No mortar that has stood more than forty minutes will be allowed to be used.

Where concrete is to be joined to concrete that has already partially set the contact surface of the latter shall be thoroughly wet and covered with a coating of neat cement paste.

All concrete while setting must be protected from freezing and from hot sunshine. It must be sprinkled twice each day for four days, or longer if required by the Engineer, unless kept sufficiently wet by rain.

The contract price for all culverts and drains shall include all necessary excavation, all required materials, laying or constructing the culverts according to specifications, and backfilling to the original surface of the ground, or to bottom of side ditch in case of lateral drains.

Cement.—All cement used on the work embraced by this contract shall be of a standard brand of Portland cement, and shall be accompanied by a certificate from the dealer showing when it was shipped from the mills.

It shall be stored where it will be protected from the weather and in such a manner that each shipment shall be kept separate from the others.

The Engineer shall at all times have access to the cement for the purpose of testing it.

At least three samples of each shipment shall be furnished the Engineer for the purpose of testing.

The tests shall be: first, for fineness; second, for constancy of volume; third, for tensile strength; fourth, chemical tests.

Fineness.—The fineness shall be such that not less than ninety-eight (98) per cent by weight shall pass through a No. 50 standard sieve, having 2,500 meshes per square inch, and not less than ninety-one (91) per cent by weight shall pass through a No. 100 standard sieve, having 10,000 meshes per square inch.

Constancy of Volume.—Pats of neat cement paste about three inches in diameter, one-half inch thick at the middle, and tapering to a thin edge shall be exposed in moist air at normal temperature. One pat is then to be kept in water and one in moist air for seven days, and one in steam above boiling water for five hours. At the end of the tests the pat shall, to meet the requirements, be hard and show no signs of distortion, checking, cracking, or disintegration. Where there is sufficient time two pats shall be kept twenty-eight days, one in water, one in air, before the cement is used in construction.

Tensile Strength.—Briquettes of neat cement mixed three minutes and pressed firmly into the molds, and kept twenty-four hours in moist air at a temperature not lower than 65 F., and in water six days, shall show a tensile strength of at least five hundred (500) pounds per square inch.

Chemical Tests.—The Commission may have chemical analyses made and reject any cement which shows adulterations or excess of ingredients which, in its judgment, renders it unsuitable for the work.

Steel.—Mesh reinforcement and deformed bars shall be placed where specified in the plans or where ordered by the Engineer. Both shall be of mild steel and of the sizes and weights per square foot specified. All reinforcement shall be placed so as to distribute, as nearly as possible, the load equally throughout the reinforcement.

Steel Bridges.—The design and specifications for steel bridges shall be embodied in a supplemental set of specifications which shall become a part of these specifications when attached hereto and properly signed.

Blanks Used in Iredell County.

The following blanks have been found very satisfactory for the work in Iredell County,* which had an organization similar to that described in this paper. The first blank is one that is used in obtaining rights-of-way for highways without any compensation to owners. The second is an agreement that is signed by persons living along the proposed road, when it has been impossible to obtain signatures to the previous documents of all land owners along the proposed road. Thus far, but very little has had to be paid for right-of-way, and in nearly all cases land-owners have been perfectly willing to sign these papers, in order to get the good road constructed:

* These blanks were prepared by W. S. Fallis, Highway Engineer.

No. U 150.

ROAD PETITION.

WHEREAS, THE PUBLIC ROAD has been designated by the Board of Commissioners of Iredell County as a proper road for immediate survey, location and building; and, whereas, it may be necessary, at many points, to survey, locate, relocate and widen said road, in order to a successful completion thereof, for the benefit of the greatest number of people in the community through which it is to be surveyed, located, relocated and built; and, whereas, we desire the completion of said road at the earliest possible moment, and the greatest number of miles of said road built out of the money to be expended for roads

NOW, THEREFORE, we, the undersigned citizens and property owners along the route of said proposed road, do hereby show our appreciation and cooperation in the progressive spirit of the county in the surveying, locating, relocating and building of said road, by granting to the county of Iredell, through its proper authority, permission to enter upon our land, survey, locate, relocate and build said road, as may be deemed advisable by said county authorities, without any compensation to us, and by reason of the construction of said road, doing as little damage as possible to the freeholders along said proposed public road.

IN TESTIMONY WHEREOF, we set our hands to this, the.....day of July, 1911.

.....

.....

.....

.....

.....

AGREEMENT.

Statesville, N. C.,, 191...

TO THE BOARD OF COUNTY COMMISSIONERS
OF IREDELL COUNTY:

Gentlemen: The party whose name or names are signed hereto mutually and severally offer and agree to hold the county of Iredell free from all cost that may be occasioned and made necessary (by the present survey) in order to obtain the "right of way" over the lands of.....

.....
for the purpose of constructing the new road known as the.....
road between and

The above offer and agreement is made in consideration of the early construction of the said road, and that it be constructed on the survey as now made. The amount of any cost or damage allowed for the right of way over the above land we offer and agree to pay, provided, that the county proceed to have the amount legally adjusted as provided by law.

.....

.....

.....

The third blank is a form of contract used for hiring teams. This is signed in duplicate: one, a white sheet, is retained by the County Road

The Engineer shall at all times have access to the cement for the purpose of testing it.

At least three samples of each shipment shall be furnished the Engineer for the purpose of testing.

The tests shall be: first, for fineness; second, for constancy of volume; third, for tensile strength; fourth, chemical tests.

Fineness.—The fineness shall be such that not less than ninety-eight (98) per cent by weight shall pass through a No. 50 standard sieve, having 2,500 meshes per square inch, and not less than ninety-one (91) per cent by weight shall pass through a No. 100 standard sieve, having 10,000 meshes per square inch.

Constancy of Volume.—Pats of neat cement paste about three inches in diameter, one-half inch thick at the middle, and tapering to a thin edge shall be exposed in moist air at normal temperature. One pat is then to be kept in water and one in moist air for seven days, and one in steam above boiling water for five hours. At the end of the tests the pat shall, to meet the requirements, be hard and show no signs of distortion, checking, cracking, or disintegration. Where there is sufficient time two pats shall be kept twenty-eight days, one in water, one in air, before the cement is used in construction.

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Chemical Tests.—The Commission may have chemical analyses made and reject any cement which shows adulterations or excess of ingredients which, in its judgment, renders it unsuitable for the work.

Steel.—Mesh reinforcement and deformed bars shall be placed where specified in the plans or where ordered by the Engineer. Both shall be of mild steel and of the sizes and weights per square foot specified. All reinforcement shall be placed so as to distribute, as nearly as possible, the load equally throughout the reinforcement.

Steel Bridges.—The design and specifications for steel bridges shall be embodied in a supplemental set of specifications which shall become a part of these specifications when attached hereto and properly signed.

Blanks Used in Iredell County.

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NOW, THEREFORE, we, the undersigned citizens and property owners along the route of said proposed road, do hereby show our appreciation and coöperation in the progressive spirit of the county in the surveying, locating, relocating and building of said road, by granting to the county of Iredell, through its proper authority, permission to enter upon our land, survey, locate, relocate and build said road, as may be deemed advisable by said county authorities, without any compensation to us, and by reason of the construction of said road, doing as little damage as possible to the freeholders along said proposed public road.

IN TESTIMONY WHEREOF, we set our hands to this, the.....day of July, 1911.

.....

.....

.....

.....

AGREEMENT.

Statesville, N. C.,, 191...

TO THE BOARD OF COUNTY COMMISSIONERS
OF IREDELL COUNTY:

Gentlemen: The party whose name or names are signed hereto mutually and severally offer and agree to hold the county of Iredell free from all cost that may be occasioned and made necessary (by the present survey) in order to obtain the "right of way" over the lands of.....

.....
for the purpose of constructing the new road known as the.....
road between and

The above offer and agreement is made in consideration of the early construction of the said road, and that it be constructed on the survey as now made. The amount of any cost or damage allowed for the right of way over the above land we offer and agree to pay, provided, that the county proceed to have the amount legally adjusted as provided by law.

.....

.....

.....

The third blank is a form of contract used for hiring teams. This is signed in duplicate: one, a white sheet, is retained by the County Road

Commission, and the duplicate, a yellow sheet, is retained by the contractor:

CONTRACT FOR HIRING TEAMS.

This Agreement, made and concluded this the day of....., 191..., between the county of Iredell, State of North Carolina, through and in the person of the County Engineer of said county, or his properly authorized agent or representative, as the party of the first part, and..... as party of the second part,

Witnesseth, That for and in consideration of the money to be paid the party of the second part by the party of the first part, at a rate per hour or day as hereinafter agreed upon, the party of the second part shall furnish to the county..... team or teams, consisting of two..each, together with harness and driver for same, and the period of such employment shall be from.....to..... The team or teams so hired by the party of the first part shall be cared for, stabled, and fed by the party of the second part at his own proper cost and expense, and the party of the first part shall have the right to use said team anywhere, during the continuance of this contract, within a radius of.....miles of

The aforesaid team or teams shall be used by the county continuously every day unless prevented by weather conditions or other unavoidable causes incident to the carrying on of the work.

If the County Engineer is of the opinion that the team so furnished, or the driver or the harness so furnished, is unfit for the work required, the party of the second part shall, upon being so informed, at once replace them with others that shall be satisfactory to the foreman in charge of the work.

The drivers of the team or teams shall be able-bodied men, not less than eighteen years of age, and when not engaged in handling their teams shall do such other work as the foreman shall direct, and shall in all respects be subject to the discipline of said foreman during the hours engaged on the work.

The teams shall work the same number of hours worked by the teams owned by the county, not ordinarily to exceed ten hours per day.

It is hereby **SPECIALLY UNDERSTOOD AND AGREED** between both parties to this contract that the party of the first part shall retain out of any money that is due, or may become due, to the party of the second part, the sum of ten dollars (\$10.00) to protect the party of the first part from loss, acknowledged and agreed to by the party of the second part, as follows: Should any team of the party of the second part be late in reaching the location of the work where it is understood that work is to be or is being done, or at such place as the foreman instructs the driver of such team to be, the sum of one dollar (\$1.00) shall be deducted for each hour or fractional part of an hour such team is late. Should the team or teams of the party of the second part be absent for an entire day during the continuance of this contract the party of the first part shall have the right to cancel this contract, and the entire sum of ten dollars (\$10.00) be deducted from the amount due said party of the second part, and the party of the second part hereby releases all right and claim to such sum deducted.

This contract shall be signed by the foreman in charge of the work and

shall be considered the agent or representative of the county in connection herewith.

The rate per hour for the service of the above team or teams shall be.....
per hour for each team with harness and driver included.

Witness.....	.....Foreman.

	Party of the Second Part.

The fourth blank is a form used for monthly report of county road work, which is made out by each foreman, handed in to the superintendent, and then transferred by him without criticisms to the Chief Engineer (page 97).

The fifth blank is the form of pay roll, that has been found very satisfactory, which is made out in triplicate: the white sheet is sent to the Treasurer of the Road Commission; the green one is posted at camp; and the yellow one is retained in the book by the foreman, which is signed by the employees. These blanks are checked up and signed by the foreman.

Similar pay roll sheets are used for grading, and all forms of construction work (pages 98 and 99).

MONTHLY REPORT OF IREDELL COUNTY ROAD WORK.

CAMP No.		191		191	
Name of Road		Work Begun			
Sta. No. to Sta. No.	Per Cent Complete	Sta. No. to Sta. No.	Per Cent Complete	Sta. No. to Sta. No.	Per Cent Complete
Grading					
Clearing					
Sta. No.	Size and Kind	Sta. No.	Size and Kind	Sta. No.	Size and Kind
Completed Culverts					
From Mr.		From Mr.		From Mr.	
Sta. No. to Sta. No.		Sta. No. to Sta. No.		Sta. No. to Sta. No.	
Acres		Acres		Acres	
From Mr.		From Mr.		From Mr.	
Sta. No. to Sta. No.		Sta. No. to Sta. No.		Sta. No. to Sta. No.	
Acres		Acres		Acres	
For Two Weeks Ending		Two Weeks Ending			
Days Worked					
Days Idle					
Remarks :-		Foreman			

Camp No.

IREDELL COUNTY ROAD PAY ROLL

For Week Ending 191.....

Cleaning.

Names	For Week Ending							Cleaning.							Amount	Signatures
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Weeks Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Weeks Time	Total Time	Price Per Hour
1																1
2																2
3																3
4																4
5																5
6																6
7																7
8																8
9																9
10																10
11																11
12																12
13																13
14																14
15																15
16																16
Total,																

BRIDGES AND CULVERTS.

Names	Weeks Time							Total Time	Price Per Hour	Amount	Signatures
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Weeks Time				
1											1
2											2
3											3
4											4
5											5
6											6
7											7
8											8
9											9
10											10
11											11
12											12
13											13
14											14
15											15
16											16
Total.											

Remarks :—

Foreman

Forms Used by Vance County Road Commission.
(This county does the work with its own forces.)

AGREEMENT.

STATE OF NORTH CAROLINA,
 VANCE COUNTY.

To the Good Roads Commission of Vance County:

GENTLEMEN:—The party whose name or names are signed hereto mutually and severally offer and agree to hold the county of Vance free from all cost that may be occasioned and made necessary (by present survey) in order to obtain the "right of way" over the land of.....

 for the purpose of constructing the new road known as the.....
 road between and

The above offer and agreement is made in consideration of the early construction of said road, and that it be constructed on the survey as now made. The amount of any cost allowed for land used for the right of way over the above land we offer and agree to pay, provided, that the county proceed to have the amount legally adjusted as provided by law.

..... (Seal.)

[Signature lines repeated.]

STATE OF NORTH CAROLINA,
 VANCE COUNTY.

Whereas, the Public Road has been designated by the Board of Road Commissioners of Vance County, as a proper road for immediate survey, location and building, and whereas, it may be necessary, at many points, to survey, locate, relocate and widen said road, in order to a successful completion thereof for the benefit of the greatest number of people in the community through which it is to be surveyed, located, relocated and built, and whereas, we desire the completion of said road at the earliest possible moment, and the greatest number of miles of said road built out of the money to be expended for roads:

Now, Therefore, We, the undersigned citizens and property owners along the route of said proposed road, do hereby show our appreciation and co-operation in the progressive spirit of the county in the surveying, locating, relocating and building of said road, by granting to the county of Vance, through its proper authority, permission to enter upon our land, survey, locate, relocate and build said road, as may be deemed advisable by said county authorities, without any compensation to us, and by reason of the construction of said road, doing as little damage as possible to the freeholders along said proposed public road.

In testimony whereof, we set our hands to this the.....day.....
 191.....

..... (Seal.)

[Signature lines repeated.]

MONTHLY REPORT VANCE COUNTY ROAD WORK.

CAMP No.		191	
Name of Road		Work Begun	
Grading	Sta. No. to Sta. No.	Per Cent Complete	Sta. No. to Sta. No. Per Cent Complete
Clearing			
Completed Culverts	Sta. No. Size and Kind	Sta. No. Size and Kind	Sta. No. Size and Kind
Soil Used	From Mr.	From Mr.	From Mr.
Completing Road	Sta. No. to Sta. No. Acres	Sta. No. to Sta. No. Acres	Sta. No. to Sta. No. Acres
	From Mr.	From Mr.	From Mr.
	Sta. No. to Sta. No. Acres	Sta. No. to Sta. No. Acres	Sta. No. to Sta. No. Acres
Days Worked	For Two Weeks Ending	For Two Weeks Ending	
Days Idle			
Remarks :-	Under "Remarks" Report any items or features of work not specified above.		
	Foreman		

STATE AID ROAD.

FOREMAN'S WEEKLY REPORT.

.....County. Week Ending.....191...
Post Office. Foreman.....

CLEANING AND GRUBBING.

.....men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
teams.....days @ \$.....per day . . . \$.....

Total \$.....

Clearing and grubbing has been done between Station..... and
 Station

GRADING.

.....men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
teams.....days @ \$.....per day . . . \$.....
teams.....days @ \$.....per day . . . \$.....

Total \$.....

Grading has been done between Station..... and Station.....

SURFACING.

.....men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
roller men.....days @ \$.....per day . . . \$.....
teams.....days @ \$.....per day . . . \$.....
teams.....days @ \$.....per day . . . \$.....
 Coal.....tons @ \$.....per ton . . . \$.....
 Gasoline.....gals. @ \$.....per gal. . . . \$.....

Total \$.....

Surfacing has been done between Station..... and Station.....

CULVERTS AND BRIDGES.

.....men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
men.....days @ \$.....per day . . . \$.....
teams hauling.....days @ \$.....per day . . . \$.....

Total \$.....

No. cu. yds. gravel, sand or rock used in culverts.....@ \$..... \$.....
 Number sacks cement used.....@ \$.....per sack \$.....
 Number feet B. M. Lumber used in bridges or forms..... \$.....

Number pounds reinforcing or steel beams used.....	\$.....
Culvert work has been done at Stations.....	
No. feet 12-inch pipe put in.....@ \$.....per lin. foot	\$.....
No. feet 15-inch pipe put in.....@ \$.....per lin. foot	\$.....
No. feet 18-inch pipe put in.....@ \$.....per lin. foot	\$.....
No. feet 24-inch pipe put in.....@ \$.....per lin. foot	\$.....

Total \$.....

Pipe has been put in at Stations.....

FORCE ACCOUNT.

.....men.....days @ \$.....per day . . .	\$.....
.....men.....days @ \$.....per day . . .	\$.....
.....men.....days @ \$.....per day . . .	\$.....
.....teams.....days @ \$.....per day . . .	\$.....

Total \$.....

Force account has been done at Stations.....

[illegible]

The following bids which were made by contractors on certain work in Greene County, Tennessee, are of interest as giving some idea of contract prices:

EIGHT BIDS SUBMITTED ON CONTRACT WORK IN GREENE COUNTY, TENNESSEE, IN 1913.

	1	2	3	4	5	6	7	8
For clearing, per acre.....	\$25.00	\$25.00	\$25.00	\$20.00	\$30.00	\$25.00	\$25.00	\$27.00
For grubbing, per acre.....	30.00	25.00	25.00	40.00	100.00	40.00	30.00	30.00
For earth excavation, per cu. yd....	.24	.22 $\frac{1}{2}$	.23	.23	.23	.23 $\frac{1}{2}$	.24	.23
For loose rock excavation, per cu. yd.....	.39	.38 $\frac{1}{2}$	.38	.37 $\frac{1}{2}$	.36	.40	.38	.39
For solid rock excavation, per cu. yd.....	.89	.82 $\frac{1}{2}$	.78	.75	.77	.85	.80	.79
For second-class masonry, per cu. yd.....	6.00	8.00	6.75	7.00	7.00	8.00	7.00	7.00
For culvert masonry in cement, per cu. yd.....	5.00	8.50	6.50	5.00	6.00	7.00 6.00	4.50	5.00
For furnishing and laying rip-rap where designated, per cu. yd.....	1.50	2.00	2.00	2.50	2.00	1.75	1.50	1.50
For paving ditches and culverts where designated, per cu. yd.....	1.75	2.25	2.00	2.00	2.00	2.25	2.00	1.75
For furnishing and putting in place all lumber under 1,000'.....	30.00	38.00	30.00	40.00	50.00	30.00	35.00	30.00
For furnishing and putting in concrete when designated, per cu. yd.	9.00	8.50	9.00	9.00	8.00	10.00	9.00	10.00

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Old Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*
23. Forest Conditions in Western North Carolina, by J. S. Holmes 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

ECONOMIC PAPERS.

1. The Maple-sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virginias, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Zircon; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of western North Carolina are described, giving distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virginina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 5 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled

by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; The new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1st, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 50 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8° 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connelly Tract, Buncome County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kigore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

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NORTH CAROLINA AGRICULTURAL AND ECONOMIC SURVEY

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EXTENDED PAPER NO. 10

FOREST FIRES IN NORTH CAROLINA DURING 1914

1915

FORESTRY LAWS OF NORTH CAROLINA

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FOREST FIRES IN NORTH CAROLINA
DURING 1914

AND

FORESTRY LAWS OF NORTH CAROLINA

BY

J. H. HOLMES, State Forester



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JOSEPH HYDE PRATT, State Geologist

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AND

FORESTRY LAWS OF NORTH CAROLINA

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LETTER OF TRANSMITTAL.

CHAPEL HILL, July 15, 1915.

To His Excellency, HONORABLE LOCKE CRAIG,

Governor of North Carolina.

SIR:—I have the honor to submit for publication as Economic Paper No. 40 of the reports of the North Carolina Geological and Economic Survey a report on the *Forest Fires in North Carolina During 1914* and on the *Forestry Laws of North Carolina*.

Since the passage of the forestry laws by the General Assembly of 1915, there has already been an increased interest shown in regard to the forests of the State and their preservation. It is believed that these laws can be made effective and that they will be the means of greatly reducing the loss due to forest fires.

Yours very respectfully,

JOSEPH HYDE PRATT,

State Geologist.

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FOREST FIRES IN NORTH CAROLINA DURING 1914

INTRODUCTION.

Public interest in forest fire prevention in North Carolina is increasing year by year. This is reflected in the State press, which chronicles and comments upon forest fires and the loss suffered by them to a much greater extent than formerly. It is also seen in the recent action of the State Legislature, which enacted an excellent forest fire law. However, the fact that the appropriation to make this law effective was denied shows that even yet public opinion is not insistent enough or definite enough to secure from the representatives of the people in the General Assembly adequate State assistance in fire protection.

The only possible reason for this condition is that our people themselves are not well enough informed on this subject. They do not yet realize the pressing necessity for a permanent supply of timber for our industries and for the people as a whole. They do not yet understand that where seedlings and young trees of our more valuable species are killed by fire our future forests will be of greatly reduced value; that burnt-over forests yield the minimum returns in timber, while protected forests yield the maximum; that unburnt forests pay the highest returns to the owners, to the community, and to the State.

Forest fires result largely from the indifference and consequent carelessness of the people. Half the fires in this State are said to be due to the carelessness of the individual. By changing this indifference into strong, active opposition to burning the woods, much of the criminal carelessness now existing in regard to forest fires will be done away with. It is with the idea of keeping the public informed as to the real conditions of the forests throughout the State, and so arousing them to the need of definite action, that these annual reports continue to be prepared and issued to the people of the State. Previous publications of the North Carolina Geological and Economic Survey in this series are "Forest Fires in North Carolina During 1909," Economic Paper No. 19; "Forest Fires in North Carolina During 1910," Economic Paper No. 22; "Forest Fires in North Carolina During 1911," Economic Paper No. 25; "Forest Fires in North Carolina During 1912," Economic Paper No. 33; and "Forest Fires in North Carolina During 1913," Economic Paper No. 37. Each of these reports contains a large amount of information about the nature of the damage done by forest fires, the causes

of fires, the various methods suggested and plans put into force to prevent them, and the laws of the various States and of the United States for their control. Copies of most of these Economic Papers can be had free upon application.

THE WEATHER.

Extremely dry weather has often been spoken of as a frequent cause of forest fires. This, however, is a misapprehension. Dry weather can no more cause a fire in the woods than a loaded gun can cause the death of a friend. It is the careless individual in both cases who causes the trouble. If carelessness could be eliminated, the forest fire "caused by dry weather" and the death caused by the gun which was "not loaded" would not occur.

But carelessness can only be overcome with thoughtfulness. In order, therefore, to reduce the number of fires, knowledge of the damage done by them must be spread and emphasized so that the general public will learn to think, and so will learn to exercise increased watchfulness and care.

The relation of carelessness and dry weather to forest fires in 1914 is seen in a casual perusal of the State press; though even now, when a knowledge of the value of our forests would seem to be almost universal, some newspapers, which claim to be leaders of public opinion, scarcely notice even the worst fires. The great majority of our State papers, however, are quick to point a lesson from each destructive fire. It is seen, by referring to the annual summary of the United States Weather Bureau reports, that the precipitation over North Carolina for the past year was "2.79 inches below normal," a deficiency of about 51½ per cent. January was a dry month, there being only about two-thirds the normal amount of rainfall. From the 4th to the 24th practically no rain fell. A very destructive fire occurred near Ridge Crest which was caused, it was said, by "careless handling of fires in the woods."

During February rainfall was about normal, but in March there was only two-thirds of the usual amount. It was, however, well distributed, and few fires were reported. The April rainfall was normal, most of it occurring, however, before the 21st of the month. From that date up to the middle of June precipitation was exceptionally light. May was the driest on record, with the exception of 1911, an average of only 1.38 inches falling, compared with a normal rainfall of 4.11 inches. The western district, usually the wettest, was drier than the central or eastern sections, and precipitation was unevenly distributed. Forest fires were reported by the newspapers from the Linville section of the mountains

and from many of the southeastern coastal plain counties. The June rainfall averaged 3.28 inches, being about 2 inches below the normal. Though rain was general about the middle of the month, forest fires raged around Beaufort up to about the 20th. They were, also, exceedingly destructive on Mount Mitchell. July was also dry, and though scattered showers fell in most places, destructive fires still continued over the greater part of the coastal plain region.

The rainfall through August and September was still below normal, but no fires were reported in the daily papers.

The last three months of the year were the only ones in which the precipitation was above the average, the December rainfall being easily the heaviest yet recorded. Early in November fierce fires were raging around the Black Mountains and at other places in the State, but the fall fires were less numerous than usual.

TABLE 1.—RELATIVE MONTHLY AND SEASONAL FIRE RISKS IN 1914 AND AVERAGE FOR FOUR YEARS IN PERCENTAGES.

	1914.	Average.		1914.	Average.
March.....	15	16.5	} Spring.....	52	53.5
April.....	20	23			
May.....	17	14			
June.....	11	6.5	} Summer.....	21	17
July.....	5	6			
August.....	5	5			
September.....	4	5	} Fall.....	21	22.5
October.....	7	7			
November.....	10	10.5			
December.....	1	3	} Winter.....	6	7
January.....	1	1			
February.....	4	2.5			

ANNUAL STATEMENT OF FOREST FIRES IN 1914.

The following tables were compiled from more than six hundred replies from voluntary correspondents all over North Carolina. Though five counties only are unrepresented, less than half the townships of the State were reported for, and most of these by only one person. Nevertheless, the figures here given, though undoubtedly much less than the actual amount of fire damage, will convey to the reader some idea of the destruction annually occurring in our State, largely as a result of carelessness.

FOREST FIRES IN NORTH CAROLINA.

TABLE 2.—FOREST FIRES IN NORTH CAROLINA DURING 1914. COMPARATIVE STATEMENT;
SUMMARY OF REPORTS FROM CORRESPONDENTS BY REGIONS.

	MOUNTAIN.		PIEDMONT.		COASTAL PLAIN.		STATE.	
	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.
Total number of townships in region.....	166		454		370		990	
Number of townships reporting.....	85	68	234	196	129	128	448	390
Number of replies received.....	117	83	348	240	161	128	626	452
Number of forest fires reported.....	176	170	212	230	281	238	669	639
Total area burnt over, in acres.....	76,000	141,000	60,000	101,000	159,000	155,000	295,000	397,000
Total standing timber destroyed, in M feet, board-measure.....	18,000	23,000	6,000	11,000	23,000	22,000	47,000	56,000
Value of timber destroyed.....	\$ 29,000	\$ 58,000	\$ 17,000	\$ 33,000	\$ 83,000	\$ 63,000	\$ 129,000	\$ 155,000
Area of young growth destroyed, in acres.....	31,000	47,000	21,000	32,000	48,000	42,000	100,000	122,000
Value of young growth destroyed.....	\$ 67,000	\$ 68,000	\$ 42,000	\$ 59,000	\$ 111,000	\$ 77,000	\$ 220,000	\$ 207,000
Value of forest products destroyed.....	\$ 87,000	\$ 73,000	\$ 26,000	\$ 54,000	\$ 72,000	\$ 84,000	\$ 185,000	\$ 212,000
Value of improvements destroyed.....	\$ 22,000	\$ 17,000	\$ 13,000	\$ 22,000	\$ 31,000	\$ 26,000	\$ 66,000	\$ 66,000
Total damage reported.....	\$205,000	\$218,000	\$ 98,000	\$170,000	\$297,000	\$253,000	\$600,000	\$ 641,000
Number of lives lost.....								2
Cost to private individuals to fight fires.....	\$ 4,400	\$ 6,000	\$ 1,900	\$ 4,400	\$ 9,000	\$ 8,100	\$ 15,000	\$ 18,600

TABLE 3.—FOREST FIRES IN NORTH CAROLINA DURING 1914. SUMMARY OF REPORTS FROM
CORRESPONDENTS BY COUNTIES.

MOUNTAIN REGION.

County.	Total Number of Townships in County.	Number of Townships Reporting.	Number of Replies.	Number of Fires.	Total Number of Acres Burnt Over.	Merchantable Timber Destroyed, M.	Value Timber Destroyed.	Acres of Young Growth Destroyed.	Value of Young Growth Destroyed.	Value of Products Destroyed.	Value of Improvements Destroyed.	Cost of Fighting Fires.
Alleghany.....	8	1	1				\$		\$	\$	\$	\$
Ashe.....	15	4	2	4	500			500	2,000		100	100
Avery.....	7	3	4	3	200			150	1,000	1,000	500	50
Buncombe.....	13	6	9	16	4,100	15,000	10,000	4,080	3,762	10,000		130
Cherokee.....	6	2	3	13	1,100	10	25	500	500			25
Clay.....	5	4	11	19	5,500	272	1,200	3,450	9,500			100
Graham.....	3	2	2	3	4,000	100	300	3,000	1,000			
Haywood.....	13	5	6	12	3,700	620	3,000	200	200	4,500	600	1,050
Henderson.....	8	6	7	1	100			3	25		150	
Jackson.....	15	3	4	9	6,650	35	6,175	200	3,000			1,273
Macon.....	11	8	14	18	11,515	25	85	1,708	4,008		11,204	182
Madison.....	16	11	13	6	3,155	523	2,075	320	1,052	780	1,050	135
Mitchell.....	9	5	8	3	300	25	190	50	40	100	100	
Swain.....	5	3	3	13	16,600	116	250	6,500	7,400	7,000	1,000	575
Transylvania.....	9	7	10	46	3,050	1,025	4,120	2,615	8,000	13,170	100	100
Watauga.....	12	6	6	3	200	50	250					25
Yancey.....	11	9	14	7	16,530	373	1,130	7,530	25,800	51,000	7,050	590
Totals.....	166	85	117	176	76,250	18,174	\$28,800	30,806	\$67,287	\$87,550	\$21,854	\$ 4,335

TABLE 4.—FOREST FIRES IN NORTH CAROLINA DURING 1914. SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES.

PIEDMONT REGION.

County.	Total Number of Townships in County.	Number of Townships Reporting.	Number of Replies.	Number of Fires.	Total Number of Acres Burnt Over.	Merchantable Timber Destroyed, M.	Value Timber Destroyed.	Acres of Young Growth Destroyed.	Value of Young Growth Destroyed.	Value of Products Destroyed.	Value of Improvements Destroyed.	Cost of Fighting Fires.
Alamance.....	13	8	12				\$		\$	\$	\$	\$
Alexander.....	8	7	8	3	12			10	25	150	100	
Anson.....	8											
Burke.....	12	5	6	4	21,200	1,250	2,500	11,200	25,200	25		300
Cabarrus.....	12	7	11	1	5	5	25	5	10	35		
Caldwell.....	12	3	4	15	11,100	300	1,500	1,000	1,000	3,000		
Caswell.....	9	5	7	4	129				250	50		
Catawba.....	8	7	11									
Chatham.....	14	4	5	6	170			135	695			
Cleveland.....	11	7	10	5	218	20	48	217	55	250		20
Davidson.....	17	6	8	1	12	15	30	12	100	100		10
Davie.....	7	7	15	2	310	12	60	8	75	400		
Durham.....	6	2	2									
Forsyth.....	14	10	13	4	41	10	50	30	275	350		12
Franklin.....	10	4	9	6	131	250	850	99	216	100	100	50
Gaston.....	6	4	8	4	195	6	24	135	650	225		70
Granville.....	9	5	9									
Guilford.....	18	8	10	2	85		100	60	150			
Iredell.....	16	6	10	1	860	100	500	200	150	300	450	75
Lee.....	7	2	2	10	623			603	760			
Lincoln.....	5	3	4	2				50	100		800	
McDowell.....	11	5	6	25	1,420	1,000	3,003	410	205			150
Mecklenburg.....	15	10	18									
Montgomery.....	11	7	8	23	8,920	15	30	130	440	491	25	170
Moore.....	9	7	15	11	4,130	103	410	1,800	1,750	2,350		280
Orange.....	7	2	2									
Person.....	9	4	4									
Polk.....	6	6	8	9	3,180	20	2,410	2,300	2,600	1,500	600	75
Randolph.....	19	7	8	6	1,000	100	300	200	500			
Rockingham.....	11	4	5	11	27	10	40	21	205	100	1,000	100
Rowan.....	14	9	12	12	760	1,000	1,100	320	1,300	650	5,300	130
Rutherford.....	12	3	3		50			50	100	10		10
Stanly.....	8	2	2	2	10	20	75	6	50	250	2,000	100
Stokes.....	8	4	5	3	3,501	100	500	200	500			50
Surry.....	14	12	15	4	540	202	410	510	625	35		75
Union.....	9	7	9	2	204	75	200	75	200	400	500	
Vance.....	9	5	7	2	7			4	30			
Wake.....	19	2	2	1	10	5	15	10	50			
Warren.....	12	5	10	13	150	100	300	95	1,175	2,500	75	55
Wilkes.....	21	15	26	13	990	915	2,415	800	2,750	12,300	1,000	185
Yadkin.....	8	8	19	5	200	100	100	210	25		1,035	
Totals.....	454	234	348	212	60,190	5,733	\$16,995	20,905	\$42,216	\$25,571	\$12,985	\$ 1,917

TABLE 5.—FOREST FIRES IN NORTH CAROLINA DURING 1914. SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES.

COASTAL PLAIN REGION.

County.	Total Number of Townships in County.	Number of Townships Reporting.	Number of Replies.	Number of Fires.	Total Number of Acres Burnt Over.	Merchantable Timber Destroyed, M.	Value Timber Destroyed.	Acres of Young Growth Destroyed.	Value of Young Growth Destroyed.	Value of Products Destroyed.	Value of Improvements Destroyed.	Cost of Fighting Fires.
Beaufort.....	6	2	3	10	2,000	2,000	\$8,000	2,000	\$ 6,000	\$6,000	\$.....	\$ 1,000
Bertie.....	9	7	10	6	1,860	115	335	710	820	1,100	200	100
Bladen.....	15	1	1	1	200	10	40	100	300			50
Brunswick.....	6	1	2	2	1,200		6,000		3,000			
Camden.....	3	1	1	1								
Carteret.....	9	2	2	1								250
Chowan.....	4	2	2									
Columbus.....	14	8	11	24	12,600	775	1,600	6,600	500	3,100	3,000	1,085
Craven.....	9	2	2		2,000							
Cumberland.....	11	4	4	14	52,000	3,050	9,150	10,500	25,550	10,100	5,000	1,150
Currituck.....	5	3	4	11	5,002			2	50		510	
Dare.....	5											
Duplin.....	13	5	5	2								
Edgecombe.....	14	2	2	2	200	50	25	5	50	100	500	25
Gates.....	7			1								
Greene.....	9	3	3	4	350	3	3	75				
Halifax.....	12											
Harnett.....	13	8	10	5	1,800	200	550	25	250	1,300	100	25
Hertford.....	6	1	1									
Hoke.....	5	1	1	1	1,000							20
Hyde.....	4	2	4									
Johnston.....	17	7	12	12	750	50	150	700	1,500		50	
Jones.....	7	2	2	3	1,000	100	200	1,000	500			100
Lenoir.....	12	7	8	8	400	4	16	300	650	8	200	10
Martin.....	10	2	2	2	10,000	100	200					
Nash.....	14	6	8	47	2,300	1,580	7,600	1,700	12,450	24,150	15,300	1,100
New Hanover.....	4			4								
Northampton.....	9	5	6	6	860			150	300	2,500		300
Onslow.....	5	3	4	26	14,000	2,500	11,500	4,500	24,500	1,000	400	1,100
Pamlico.....	4	2	2	6	2,325	1,500	4,000	400	1,600	1,500	2,000	10
Pasquotank.....	6	1	1	1	100	50	300	100	300	300		
Pender.....	10	4	6	20	13,250	835	1,780	6,050	16,050	640	300	300
Perquimans.....	5	2	2									
Pitt.....	11	3	6	9	12,200	30	90	3,000	6,500			10
Richmond.....	7	1	1	2	500					500	500	100
Robeson.....	19	7	10	22	10,700	2,800	8,000	9,250	7,600	14,000	1,500	1,010
Sampson.....	16	8	7	18	9,250	5,010	21,010	700	1,500		100	1,225
Scotland.....	4	2	2	2	250		2,000			3,500		
Tyrrell.....	5	1	1	1	400	100	200	400	500			50
Washington.....	4	3	4	1	50			50	250			
Wayne.....	12	6	7	1	10	2,000	5	5	20	20		25
Wilson.....	10	2	2	5	100	100	200	25	200	2,000	1,000	
Totals.....	370	129	161	281	158,657	22,962	\$82,954	48,347	\$110,940	\$71,818	\$30,660	\$ 9,045

TABLE 6.—FOREST FIRES IN NORTH CAROLINA DURING 1914. COMPARATIVE STATEMENT OF AVERAGES BY REGIONS FOR 1914 AND FOR SIX YEARS.

	MOUNTAIN.		PIEDMONT.		COASTAL PLAIN.		STATE.	
	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.
Percentage of townships reporting...	51	41	52	43	35	34	45	39.5
Average area of each fire, in acres...	448	898	306	447	583	656	462	624
Average damage by each fire.....	\$1,209	\$1,412	\$ 491	\$ 729	\$1,082	\$1,082	\$ 939	\$ 1,016
Average area burnt over per township reporting, in acres.....	896	*1,649	254	*717	1,230	*1,292	657	*964
Average damage per acre burnt.....	\$ 2.70	\$ 1.50	\$ 1.62	\$ 1.65	\$ 1.87	\$ 1.79	\$ 2.03	\$ 1.60
Average damage per township reporting.....	\$2,417	\$3,302	\$ 411	\$ 861	\$2,297	\$1,565	\$1,335	\$ 1,657

*No township figures for 1909.

TABLE 7.—CAUSES OF FOREST FIRES IN NORTH CAROLINA IN 1914 BY REGIONS, COMPARED WITH SIX YEARS, IN PERCENTAGES.

	1914.				Average for Six Years.
	Mountain.	Piedmont.	Coastal Plain.	State.	
Farmers burning brush, grass, rubbish, etc.....	12	7.5	4	7	11
Hunters.....	19	7.5	8.5	11	11.5
Cigars, cigarettes, matches, etc.....	3	4.5	5	4	3
Carelessness.....	15	13	15	14	18
Railroad locomotives, sparks from.....	8	35	14	20	18.5
Logging locomotives, dummy engines, etc.....	5	2	18	8.5	7
Sawmills, etc.....	3	4.5	2	3	4
Traction engines.....		.2		1	.5
Accidental, caught from burning building, etc.....			2	1	.5
To improve the range.....	5	8	7	7	4
Set by chestnut gatherers, root diggers, etc.....	1			.5	1
Without object, "to see it burn".....	3		1	1	3
Malice or incendiary.....	12	4.5	8.5	8	7
Unknown causes.....	5	4.5	10	7	8
Lightning.....		3	4	2.5	1
Loafers, trespassers, etc.....	1	2	1	1.5	1
Campers.....	8	1		2.5	1
Tar kilns.....		1		.5	

The foregoing tables show a total reported damage from forest fires in 1914 of \$600,000, half of which occurred in the coastal plain counties. This is slightly less than the average loss for the past six years, though very near the average in most particulars.

The most encouraging feature is the reduction of 25 per cent in the reported area burnt over, and this in spite of the fact that there were more than the average number of fires. This would indicate that more general efforts are being made to extinguish fires after they have started;

and this is corroborated by the various newspaper accounts of the fires. This interpretation, however, is not borne out by figures of cost to private individuals, who are reported to have spent less money than during the previous year in fighting fires and considerably less than the average amount. The incompleteness of the reports is responsible for this apparent contradiction. For example, a devastating fire occurred in the northern parts of Camden and Gates counties at the end of July, which was not mentioned in the voluntary reports, yet large private expense was incurred in efforts to control it. The *New Bern Journal* says:

"Several hundred men have been rushed to the scene by the Richmond Cedar Works, John L. Roper Company, and Camp Manufacturing Company, principal owners of the timber in the forest tract, to fight the spread of the fire. All operations in near-by camps were suspended by the Cedar Works Company yesterday and 150 men rushed to the fire on special trains."

It seems safe to assume, from all indications, that the people are rapidly becoming more actively opposed to forest fires, and that their changed attitude is already having some effect. Yet there is much to be done by North Carolinians, both as private landowners and as citizens of a sovereign State. In the former rôle there is a large field of usefulness in the practice of coöperative fire protection, while in the latter capacity one of the first duties is to spread a knowledge of and respect for the State forestry laws.

ORGANIZED FIRE PROTECTION.

That organized fire protection, whether private, as was recently practiced on the Biltmore estate, or coöperative, as is now being worked out in Virginia, Kentucky, and other States, or governmental, *i. e.*, State and Federal, can be successfully practiced in North Carolina is being demonstrated afresh on and near the National Forests in the western part of the State. Not only have the local forest officers extinguished many fires on the lands under their charge, but they have fought fires on surrounding lands with the primary object of preventing their spread to the National Forests.

Two extracts taken from the State press show the importance of having experienced men in the neighborhood who can organize and lead fire-fighting forces, who know exactly what to do, and have the authority to go ahead and do it. Speaking of a Buncombe County fire, occurring in January, one newspaper says:

"The fire started near midnight Friday night and had gained great headway before the alarm was spread and the corps was organized to fight it. All the available men in the adjacent territory were organized under the direction of

United States Forester Young and scattered over the district threatened by the leaping flames. Fighting with grim determination and never giving up hope for a single moment, this force finally confined the spreading flames in a certain area, although at times in the early morning it seemed that every residence in a radius of several miles would be destroyed."

Of a November fire in the same region, another newspaper says:

"Forest fires which have been raging in various sections of the mountains around Black Mountain during the greater part of the week are reported to have done considerable damage, the greater number of the outbreaks being reported from the Craggy Mountains. For a while fear was entertained that the flames would get on the immense watershed holdings of the city of Asheville, but reports from the intake are to the effect that but little damage has been suffered by the municipality. Mr. Bishop of Marion, representing the Government, is in charge of a force of 100 men in the Bee Tree section, and back-firing has been resorted to in checking flames."

RESULTS OF FEDERAL PROTECTION IN NORTH CAROLINA.

A striking tribute to the value of organized fire protection is brought out by some figures in Table 6. It is seen that the average area burnt over by each fire in the mountain region during the past year was exactly half the average for the past six years, while in the other regions of the State there has been only a comparatively small reduction. The only way to account for this is that the assistance and example of the Federal forest officers have had a decided effect in reducing the amount of burnt land areas.

This explanation is supported by the figures compiled by the forest officers themselves:

TABLE 8.—FOREST FIRES IN THE SOUTHERN APPALACHIAN PURCHASE AREAS IN NORTH CAROLINA, 1914.

NAME OF FOREST.	AREA OF FOREST.	NUMBER OF FIRES.				LOCATION.				NATIONAL FOREST LANDS.		
		Under 1 Acre.	Under 10 Acres.	Over 10 Acres.	Total.	Fires Originating—				Area Burned Over.	Value of Timber Destroyed.	Value of Reproduction Destroyed.
						Inside Forest.	Outside Forest.	On National Forest Lands.	On Private Lands.			
Mount Mitchell.....	66,213	4	6	11	21	5	1	15		372	\$ 36	\$ 169
Pisgah.....	86,700											
Nantahala.....	36,973		10	12	22		7	15				
Savannah (N).....	34,808	1	1		2	2				1		1
Totals.....	224,694	5	17	23	45	5	9	1	30	373	\$ 36	\$ 170

The above table was prepared from the Federal Forest Examiners' annual reports. It shows the number of fires of different classes occurring within the Federal Purchase Areas in 1914 and the amount of National forest land burnt over.

It will be seen that only six fires occurred on the National Forest lands in North Carolina. The rest probably threatened the Government lands, but were extinguished before they crossed onto them. These six fires burnt over only 372 acres, or an average area for each fire of 62 acres.

RESULTS OF PARTIAL PROTECTION.

Through the coöperation of the Federal Forest officials in western North Carolina accurate information in regard to forest fires in twenty townships or parts of townships surrounding the National Forests was supplied and it is incorporated with all the foregoing tables except the last. Because of the comparative completeness of this information, and in view of the fact that efficient fire protection was practiced over parts of the townships in question, these auxiliary reports have also been compiled by themselves to show the result of partial fire protection.

The Government lands lying within these townships are thoroughly patrolled, and only six fires occurred on them, as shown in Table 8. Private land within the National Forests or outside the forests but within the purchase areas, namely, within the limits set by the Government for making further additions to the National Forests, are not patrolled, but forest officers usually assist in extinguishing fires, especially if Federal lands, or lands which have been offered to the Government, are threatened. There were thirty-nine such fires reported in 1914. The remaining thirty-five fires included in Table 9 probably occurred beyond the Government rangers' field of duty, and so were extinguished in the ordinary way, namely, by private citizens, by rain, or by burning themselves out. The following table, therefore, shows the results of partial protection in the comparison of these figures with the average ones for the mountain region found in Table 6.

TABLE 9.—GENERAL FIRE DAMAGE IN THE MOUNTAINS DURING THE PAST SIX YEARS COMPARED WITH THAT IN PARTIALLY PROTECTED TOWNSHIPS.

	In Townships and Parts of Townships Partially Protected, 1914.	In the Moun- tain Counties as a Whole. Average for the Past Six Years.
Average area of each fire, acres.....	148	898
Average damage by each fire.....	\$ 514.00	\$ 1,412.00
Average damage per acre burnt.....	3.46	1.50
Average cost of fighting fires, per fire.....	11.00	35.00

From the above table it can be seen that the average fire, where only partial protection was given, was one-sixth the size of the average fire of the region, or a saving in the eighty fires reported by the forest officers of 60,000 acres not burnt over. At an average damage of \$1.50 per acre, this means an actual saving of \$90,000.

The saving in cost of fighting fires is just as startling. While it is often said that fire fighting is now done voluntarily in North Carolina, the average cost to fight fires in the mountains is \$35 per fire, borne by landowners and private individuals. In this partially protected area under discussion the cost to private owners and the Government combined has been reduced to \$11 per fire. This seems to be indisputable evidence that organized fire protection will and does pay.

FORESTRY LAWS OF NORTH CAROLINA.*

INTRODUCTION.

The General Assembly of 1915 enacted more legislation for the conservation of our natural resources than any previous one in the history of the State. The eastern fisheries, part of which had been protected, but the greater part exploited almost without restriction, were all put under a State-wide Fisheries Commission. This law ought to insure the growth of our fishing industry which for a long while has been steadily declining. The Highway Commission bill, though not, strictly speaking, a conservation measure, is one of the most complete and effective laws for the encouragement and construction of good roads now in force in the South; and good roads are so closely connected with conservation that it is difficult to separate them.

The new laws connected with forest conservation, though not as complete and effective as the two already mentioned, because unsupported by any appropriation, cover, however, a wider field, and definitely commit the State to two policies, new in North Carolina, though well tried and permanent in many other States of the Union. These policies are: (a) State protection of the private as well as public forest lands of the State from fire, in the same way that cities and towns provide for the protection of the property of their citizens; (b) the purchase and administration of forest land by the State for the purposes of demonstration and experiment, for the recreation, health, and pleasure of its citizens, and for the protection of its streams.

In order that a clear understanding may be had of the administration of the new forest fire law and the "State forest" law, the enforcement of which is intrusted to the State Geological Board, the law creating this board is here introduced.

THE STATE GEOLOGICAL BOARD.

The General Assembly of 1905 reorganized the State Geological Survey, enlarging its scope and changing its name to the State Geological and Economic Survey. At the same time the Survey was given additional powers and duties to those it already possessed dealing with the investigation and development of the natural resources of the State.

*See Press Bulletin No. 147, N. C. Geol. and Econ. Survey, "Forestry Laws of North Carolina."

LAW CREATING THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.*

SECTION 4429. *State Geologist appointed by Governor.* The Governor shall appoint a suitable person as State Geologist to conduct, under the supervision of a board of managers to be known as the Geological Board, a geological and economic survey of the State.

SEC. 4430. *Geological Board, how appointed; meetings.* The Geological Board shall consist of the Governor (as chairman), four citizens of the State, two for a period of two years and two for a period of four years from March 1, 1905, the same to be appointed by the Governor by and with the advice and consent of the Senate, and their successors to be in like manner appointed each for a period of four years. In case of the death or resignation of either of said citizens, his successor shall be appointed by the Governor. The Geological Board shall meet twice each year, once in January and once in June, in the city of Raleigh, on the call of the Governor, except that the board may change the time and place of meeting as circumstances may require.

SEC. 4431. *Experts and assistants.* The State Geologist shall appoint, subject to the approval of the Geological Board, such experts and assistants as may be found necessary to enable him to carry out successfully and speedily the work of the Survey.

SEC. 4432. *Objects of Survey.* The Survey shall have for its objects:

1. An examination of the mineral, forest, fishery, and other material resources of the State.
2. An examination of the geological formations of the State with reference to their economic products.
3. An examination of the road-building materials and the best methods of utilizing the same.
4. An examination and classification of the soils, the forests, and other physical features of the State, with special reference to their bearing upon the occupation of the people.
5. An examination of the streams and water-powers of the State, with special reference to the development for manufacturing enterprises and the preservation of the sources of these streams through the protection of the forests.
6. The consideration of such other scientific and economic problems as in the judgment of the Geological Board shall be deemed of value to the people of the State.
7. The preparation of such reports, illustrations, and maps as may be deemed necessary in placing the results of these investigations before the public.
8. And the State Geologist, with the approval of the Geological Board, is hereby authorized to arrange for and accept such aid and coöperation from the several United States Government bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this chapter.
9. An examination of the water supplies of the State, with special reference to the sinking of deep or artesian wells.

SEC. 4433. *Reports.* The Geological Board shall cause to be prepared and submitted to each Legislature a report showing the progress and expenditures

*Chapter 94, Revisal of 1905.

of the Survey; it shall also cause to be prepared for publication such other reports, with necessary illustrations and maps, as will adequately set forth the geology and material resources of the State, all such reports, illustrations, and maps to be printed and distributed as the Geological Board may direct in editions of 3,000 copies each at the expense of the State as other public documents.

SEC. 4434. *Appropriation.* The sum of \$10,000 annually, or so much thereof as may be necessary, is hereby appropriated out of any moneys in the Treasury not otherwise appropriated for the purpose of carrying out the provisions of this chapter.

Soon after the passage of this law and the general reorganization of the Survey by the new State Geologist, Joseph Hyde Pratt, three important divisions, *i. e.*, the Highway, the Fisheries, and the Forestry divisions, were made; other interests of the Survey, such as the geological and mining work, were not delegated to any particular division.

The Highway Division has organized and pushed the good roads movement in this State by holding meetings, furnishing speakers in support of local road bond issues, and founding and assisting the North Carolina Good Roads Association. It has administered and carried out the provisions of the highway assistance law (chapter 915, Public Laws 1909) which enables the Geological Board "to advise with the township and county authorities in the building and improvement of the public roads, by sending to the township or county a competent road engineer, who will assist them in locating their improved roads, advise them," etc.

The Fisheries Division has supervised the administration of the old fish commission law (chapter 977, Public Laws 1907), which protected the northern part of Pamlico Sound and the inner waters of Albemarle Sound. It has consistently urged the extension of this law to the whole coast, which, owing to its unceasing efforts, has just been accomplished.

The Forestry Division, which was regularly organized in 1908, has examined and reported on the forests of the State, studied the forest fire question, and continuously urged forest fire legislation, and has effectively aided in the organization and support of the North Carolina Forestry Association. It has taken part in meetings, has issued publications and statements to the press, and carried on general propaganda work. It has at several different times received the coöperation of the United States Department of Agriculture in investigative forestry work.

It seems, therefore, only natural and appropriate that the administration of the forestry law, which has for eight or ten years been unceasingly advocated by the Survey and the need for which has been set forth in most of its forestry publications, should be committed to it. The Forester of the Survey is the only technical forester employed by the

State. He is in close touch with all the forestry work, and especially with the forest fire conditions over the State, as no other man can be.

It has always been the custom for the Governor to appoint the members of the Geological Board without any special reference to their political affiliation, but because of their ability and their knowledge of conditions with which they have to deal. The State Geologist is likewise appointed with the one idea of his fitness for the position, and the employees of the Survey are employed in like manner. The State Geological and Economic Survey is therefore known as a nonpolitical organization, and for this reason is especially suited for carrying on work of a technical character, which, as all experts agree, must for its fullest efficiency be absolutely divorced from politics.

LAWS FOR THE PROTECTION OF THE FORESTS FROM FIRE.

North Carolina is said to have had the first law against setting fire to woods of any State in the Union. Certain it is that in 1777 "at a General Assembly, begun and held at New Bern, on the Eighth Day of April in the Year of Our Lord One Thousand Seven Hundred and Seventy-seven, and in the First Year of the Independence of the said State: Being the first session of this Assembly," Richard Caswell, Esq., being Governor, a law was passed to prevent burning the woods.

This law, here quoted in full from The State Records of North Carolina, vol. 24, has remained in force up to the present year with the exception of those changes made necessary by the freeing of the slaves and by the passing of the whipping-post. This latter institution might even yet be found an effective method of dealing with "vagrant persons."

THE LAW OF 1777.

AN ACT TO PREVENT BURNING THE WOODS.

I. Whereas the frequent burning of the Woods is found to be destructive to Cattle and Hogs, extremely prejudicial to the Soil, and oftentimes of fatal Consequences to Planters and Farmers, by destroying their Fences and other Improvements: For Prevention of which Evils,

II. *Be it Enacted by the General Assembly of the State of North Carolina, and it is hereby Enacted by the Authority of the same,* That it shall not be lawful for any Person whatsoever to set Fire to any Woods except it be his own Property, and in that Case it shall not be lawful for him to set Fire to his own Woods, without first giving Notice to all Persons owning Lands adjacent to such Wood Lands intended to be fired at least Two Days before the time of setting such Woods on Fire, and also taking effectual Care to extinguish such Fire before it shall reach any vacant or patented Lands, contiguous to or adjacent such Lands so fired.

III. *And be it further Enacted, by the Authority aforesaid,* That every Person offending against this Act shall forfeit and pay the sum of Ten Pounds, to be recovered by Action of Debt, Bill, Plaint or Information, to the Use of the Person who shall sue or prosecute for the same; and shall also be further liable to the Party injured by such unlawful firing of the Woods, for all damages that may accrue therefrom.

IV. *And be it further Enacted, by the Authority aforesaid,* That if any Slave, Free Negro or Mulatto, or vagrant Person, unable to pay the fine aforesaid, shall be convicted of setting fire to any Woods, contrary to the true Meaning of this Act, such Person, on Conviction thereof, shall have and receive on his bare back Thirty Nine Lashes, well laid on, at the Public Whipping-Post.

Hon. Francis D. Winston, in his recent address before the North Carolina Pine Association, in speaking of the work of the North Carolina Forestry Association, emphasized the fact that this law was not enacted for the purpose of protecting the forests, but of preventing injury to live stock ranging in the vast areas of then unowned and unoccupied land. He says:

"Not a word is said about the destruction of timber by fires. A century and a half ago our ancestors were enacting laws against the destruction of hogs in the woods by fires. Today the North Carolina Forestry Association is seeking enactments to protect the woods from the hogs by a general stock law. Our association recognizes that a year's supply of timber on the farm is as necessary as the year's supply of corn and meat. We are seeking to convince the people who own lands that in the place of every tree removed for any cause a new tree should be planted. We have in view the establishment of experimental forestry farms about the State. The North Carolina Geological and Economic Survey is fostering this work."

In 1885 a law forbidding wagoners and other campers to leave their camp-fires without totally extinguishing them was passed. There has been, however, no very general enforcement of either of these laws, though there have been no others covering what we now consider these very serious offenses. These two laws (sections 3346 and 3347, Revisal of 1905) have now largely been incorporated in the new forest fire law, in slightly amended form.

MORE RECENT ATTEMPTS TO SECURE EFFECTIVE LAWS.

In 1909 an effort was made to obtain increased protection for our mountain forests by the passage of a law (chapter 89, Public Laws 1909) which allows "any owner or owners of wooded land situated in North Carolina above contour line 2,000 feet" to apply to the Governor for the establishment of such land as a "State forest." The owners pledge them-

selves to cut the timber conservatively, and to pay annually one-half cent for each acre of such proposed State forest into the county school fund. In return for this the rangers employed by the landowner are to be appointed State forest wardens, with power to arrest without warrant violators of the State laws relating to the care of forests. The owners of the land which is thus proclaimed a State forest must, of course, pay the salary and expenses of their own wardens. This law, which requires a man, in addition to bearing all the costs of fire protection, to pay out half a cent an acre for all the land protected, none of which is used for fire protection, is so manifestly one-sided that no advantage has yet been taken of it, and probably none ever will be. In contrast with this, forest fire protective associations are now being organized in several of the Appalachian States whose maximum annual assessment is only half a cent an acre. For this amount the lands are being successfully protected against fire.

There have been many other attempts, both before and since, to secure more adequate State assistance in the prevention and extinguishment of forest fires. As early as 1887, Hon. Francis D. Winston reminds us, he himself introduced a bill for this purpose into the State Senate, but it did not get out of the committee. At each regular session of the Legislature for the past eight years the State Geological and Economic Survey has proposed and urged the passage of definite legislation to reduce the enormous annual loss by forest fires, but with no definite result. The public demand throughout the State has not been strong enough to overcome the natural reluctance of such a conservative body as the General Assembly to enact restrictive laws.

But year by year, as the annual loss from fires has become better known and appreciated, the demand for protection has become more insistent, until the Legislature of 1915 responded by the enactment of an excellent law, though without appropriation.

A law to meet certain particular cases, where logging was being done on land adjoining city watersheds, was passed two years ago.* Though fairly effective in the cases to which it applies, this law, it is thought, has not yet been invoked. It can probably be effectively enforced, however, in connection with the new forest fire law.

In the following pages the forestry laws of the State are given, each accompanied by comments explaining the objects and operations of the law.

*See page 33.

THE NEW FOREST FIRE LAW.*

AN ACT TO PROTECT THE FORESTS OF THE STATE FROM FIRE.

The General Assembly of North Carolina do enact:

SECTION 1. That the State Geological Board may take such action as it may deem necessary to provide for the prevention and control of forest fires in any and all parts of this State, and it is hereby authorized to enter into an agreement with the Secretary of Agriculture of the United States for the protection of the forested watersheds of streams in this State.

SEC. 2. That the forester of the State Geological and Economic Survey, who shall be called State Forester, and shall be *ex officio* State Forest Warden, may appoint, with the approval of the Geological Board, one township forest warden and one or more district forest wardens in each township of the State in which the amount of forest land and the risks from forest fires shall, in his judgment, make it advisable and necessary.

SEC. 3. The State Forester, as State Forest Warden, shall have supervision of township and district forest wardens, shall instruct them in their duties, issue such regulations and instructions to the township and district forest wardens as he may deem necessary for the purposes of this act, and cause violations of the laws regarding forest fires to be prosecuted.

SEC. 4. Forest wardens shall have charge of measures for controlling forest fires; shall make arrests for violation of forest laws; shall post along highways and in other conspicuous places, copies of the forest fire laws and warnings against fires, which shall be supplied by the State Forester; shall patrol during dry and dangerous seasons under the direction of the State Forester, and shall perform such other acts and duties as shall be considered necessary by the State Forester for the protection of the forests from fire. The township forest warden of the township in which a fire occurs shall within ten days make such a report thereof to the State Forester as may be prescribed by him. The township forest warden of the township in which a fire occurs shall within ten days make such a report thereof to the State Forester as may be prescribed by him. Each district forest warden shall promptly report to township wardens any fire in his district.

SEC. 5. Any person who shall maliciously or willfully destroy, deface, remove, or disfigure any sign, poster, or warning notice, posted by order of the State Forester, under the provisions of this act or any other act which may be passed for the purpose of protecting the forests in this State from fire, shall be guilty of a misdemeanor, and upon conviction shall be punishable by a fine of not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days.

SEC. 6. Forest wardens shall prevent and extinguish forest fires in their respective townships and enforce all statutes of this State now in force or that hereafter may be enacted for the protection of forests and woodlands from fire, and they shall have control and direction of all persons and apparatus while engaged in extinguishing forest fires. Any forest warden may, arrest, without a warrant, any person or persons taken by him in the act of violating any of the said laws for the protection of forests and woodlands, and bring

*Chapter 243, Public Laws 1915. See Press Bull. 147, N. C. Geol. and Econ. Survey.

such person or persons forthwith before a justice of the peace or other officer having jurisdiction, who shall proceed without delay to hear, try, and determine the matter. During a season of drought the State Forester may establish a fire patrol in any township, and in case of fire in or threatening any forest or woodland the township or district forest warden shall attend forthwith and use all necessary means to confine and extinguish such fire. The said forest warden may summon any male resident of the township between the ages of 18 and 45 years to assist in extinguishing fires, and may require the use of horses and other property needed for such purpose; any person so summoned, and who is physically able, who refuses or neglects to assist or to allow the use of horses, wagons, or other material required, shall be liable to a penalty of not less than \$5 nor more than \$50. No action for trespass shall lie against any forest warden or person summoned by him for crossing or working upon lands of another in connection with his duties as forest warden.

SEC. 7. Forest wardens shall receive compensation from the Geological Board at a rate of not to exceed 20 cents per hour for the time actually engaged in the performance of their duties; and reasonable expenses for equipment, transportation, or food supplies incurred in fighting or extinguishing any fire, according to an itemized statement to be rendered the State Forester every month, and approved by him. Forest wardens shall render to the State Forester a statement of the services rendered by the men employed by them or their district wardens, as provided in this act, within one month of the date of service, which said bill shall show in detail the amount and character of the service performed, the exact duration thereof, the name of each person employed, and any other information required by the State Forester. All accounts of the forest wardens must be duly sworn to before a justice of the peace, notary public, or other officer qualified to witness such papers within the county in which the expenses were incurred. If said bill be duly approved by the State Forester, it shall be paid by direction of the Geological Board out of the funds hereinafter provided for.

SEC. 8. If any person shall intentionally set fire to any grass land, brush land, or woodland, except it be his own property, or in that case without first giving notice to all persons owning or in charge of lands adjoining the land intended to be fired, and also taking care to watch such fire while burning and taking effectual care to extinguish such fire before it shall reach any lands near to or adjoining the lands so fired, he shall for every such offense be guilty of a misdemeanor and shall be fined not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days. This shall not prevent action for damages sustained by the owner of any property from such fires.

SEC. 9. Any wagoner, hunter, camper, or other person who shall kindle a camp-fire or shall authorize another to kindle such fire, unless all combustible material for the space of 10 feet surrounding the place where said fire is kindled has been removed, or shall leave a camp-fire without fully extinguishing it, or who shall accidentally or negligently by the use of any torch, gun, match, or other instrumentality, or in any manner whatever start any fire upon any grass land, brush land, or woodland without fully extinguishing the same, shall be guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days.

SEC. 10. All persons, firms, or corporations who shall burn any tar kiln or pit of charcoal or set fire to or burn any brush, grass, or other material, whereby any property may be endangered or destroyed shall keep and maintain a careful and competent watchman in charge of said kiln, pit, brush, or other material while burning. Any person, firm, or corporation violating the provisions of this section shall be punishable by a fine of not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days. Fire escaping from such kiln, pit, brush, or other material while burning shall be *prima facie* evidence of neglect of these provisions.

SEC. 11. For the purposes of this act woodland is taken to include all forest areas, both timber and cut-over land, and all second-growth stands on areas that have at one time been cultivated.

SEC. 12. All laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 13. This act shall be in force from and after its ratification.

Ratified this the 9th day of March, A. D. 1915.

Administration.

By placing the administration of the forest fire law with an already existing office of the State Government the tedious and often difficult task of bringing together a new organization has been obviated. In view of the fact that no appropriation accompanies the new law, this provision is shown to be a wise and statesman-like action. The State Geological and Economic Survey, which unfortunately yet has only a small appropriation for its support, is enabled to spend as much as can be spared of its appropriation for the carrying out of the provisions of the law. In the actual work of fire prevention and extinguishment very little can be done without an appropriation, but along other lines the Survey has already taken active steps, chiefly toward informing the public as to what the law is and in what ways it should be observed.

Coöperation.

The latter half of section 1 contemplates a coöperative agreement with the United States Department of Agriculture under the Weeks law, whereby the State can receive very material assistance in the prevention of fires. Section 2 of the Weeks law* reads as follows:

SEC. 2. That the sum of \$200,000 is hereby appropriated and made available until expended, out of any moneys in the National Treasury not otherwise appropriated, to enable the Secretary of Agriculture to coöperate with any State or group of States, when requested to do so, in the protection from fire of the forested watersheds of navigable streams; and the Secretary of Agriculture is hereby authorized, and on such conditions as he deems wise, to stipulate and agree with any State or group of States to coöperate in the

*36 Stat., 961. See Press Bul. 147, Appendix.

organization and maintenance of a system of fire protection on any private or State forest lands within such State or States and situated upon the watershed of a navigable river: *Provided*, that no such stipulation or agreement shall be made with any State which has not provided by law for a system of forest fire protection: *Provided further*, that in no case shall the amount expended in any State exceed in any fiscal year the amount appropriated by that State for the same purpose during the same fiscal year.

As no appropriation is made by the State for fire protection, this law can be invoked at present only to a very limited extent. Under the rulings of the United States Forest Service the legal regular apportionment of State moneys paid out for fire preventive measures can be counted in the same way as a direct appropriation. The State Geologist has recently arranged for an expenditure of \$2,000 per year for the next ten years for this purpose. As a result of this arrangement, an annual apportionment of Federal funds up to the same amount has been secured; to be used, according to the ruling of the United States Department of Agriculture, for patrol and lookout work on forests covering the headwaters of streams in the western part of the State.

In addition to this, there are now being advanced tentative plans for a scheme of coöperation with county and township governments, or with groups of private landowners, whereby they may be able to obtain the benefits of the new law without any large State expenditure.

Appointment of Forest Wardens.

The township and district forest wardens, whose appointment by the State Forester is permitted under section 2, should be men of known fitness for the work which they are to undertake. They should be residents of the county and township in which they are to work, should be familiar with all parts of their district, should be men used to the woods, experienced in fighting fires, on good terms with their neighbors, strong, healthy, absolutely honest, and able to make out intelligently such few reports as will be required of them. Where such men are willing to devote a part of their time to the service of the State, receiving only such compensation as is provided in the law, the number of fires will undoubtedly be greatly reduced, as has been the experience under similar conditions in many other States.

It is not proposed to appoint wardens in every township or county in the State, because in many their services are not required, the small areas of woodland and the attitude of the public against forest fires making the services of a forest warden unnecessary. During the past six years in which figures on forest fires have been collected the greatest

part of the destruction has occurred in the mountain and coastal plain counties. These counties would, therefore, require the larger number of forest wardens. Many of the piedmont counties, however, have suffered considerably from fires, and where this has been the case, and the people are willing and anxious to coöperate in trying to prevent fires, the appointment of wardens would probably be made. As a general proposition, it may be stated that in townships containing less than 60 per cent of forest land forest wardens would not be needed, while in those having more than this proportion wooded a considerable number of them might be expected to need wardens.

Even when an appropriation is made by the State for the carrying out of this part of the law no indiscriminate appointment of wardens will be made. Each township will be considered upon its own merits, and only after careful consideration of local conditions and public sentiment, as well as of the fitness of the man proposed, will an appointment be made.

Prosecutions.

The object of this law is not the persecution of private citizens, but the prevention of forest fires. The majority of fires are caused by carelessness, and in most localities these can be gradually lessened by bringing before the people various kinds of reminders to be careful. When carelessness becomes gross or criminal a prosecution is often the only reminder that will have any effect.

But some fires are started intentionally, in plain violation of law. In such cases it is the evident duty not only of the law officers, but of every law-abiding citizen, to do everything possible to bring the offender to justice.

Though the enforcement of the forestry laws is the special duty of the forest wardens for whose appointment provision is made in the new law, prosecutions can also be taken up in the ordinary way. In fact, over the greater part of the State law enforcement will have to come through the regular county and township officers.

Where evidence is obtainable, any citizen or officer of the law can swear out a warrant before a justice of the peace which will be immediately executed by the law officer. The offender will then be tried in the magistrate's court, following the usual procedure. Should a sheriff, deputy sheriff, or township constable discover some one in the act of violating the law, he should arrest him without warrant, take him immediately before a justice of the peace, where the necessary papers would be made out and the trial proceed with the arresting officer as witness.

Forest wardens have the same power as constables and sheriffs to arrest without warrant those taken in the act of violating the forestry laws. In all other cases they must swear out warrants before a magistrate, just as a private citizen would be required to do. They cannot serve a warrant, but it must be turned over to the constable and served in the regular way.

It will, however, be the special duty of the forest warden to work up evidence against all persons suspected of violating the forestry laws. His knowledge of the region and of the people of the region will give the warden a great advantage in this respect. He should be able to find out the cause of a fire without delay, and it is his duty to do so. He must then secure sufficient evidence, swear out a warrant, and, if necessary, appear himself as a witness in the case. Forest wardens are appointed to protect the forests of the State from fire, and this they must do to the utmost of their ability, carrying out the laws enacted for that purpose.

Forest Wardens.

The regulations and instructions contemplated in section 3 will cover such duties as are not specifically mentioned in the law. Included in them would be the manner of procedure in case of fire; instructions as to the best methods of fighting fires in various cases; the organization of a fire-fighting force; the necessary preparations for a fire season; the time when patrol must be undertaken; methods of investigation into the causes of fires; the collection of evidence for prosecutions; and many other things in regard to the daily duties of the wardens.

The duties of fire wardens mentioned in section 4 are those which are universally recognized as the usual duties of such officers. Other duties and acts may be necessary in certain cases, or as conditions which are not now foreseen arise from year to year. These other duties will be such as any employer of help might require of those under him, and will of course be in strict accordance with this and all other laws of the State.

The reports required from forest wardens are necessary not only that the State Forester may be in close touch with the wardens and with fire conditions in the various districts, but also as a check on the monthly accounts sent in by the wardens, which have to be paid after approval by the State Forester. The reports will be as simple and brief as is consistent with the information desired. Blank forms will be printed, so that only a small amount of writing will be necessary. These reports will form the basis of the annual report of the State Forest Warden

as to the number of fires, the area burnt over, the damage done, and the cost to the State in preventing and extinguishing fires. In districts where wardens are appointed these reports will supersede the voluntary reports now sent in in regard to forest fires.

Patrol.

Patrol is an important duty of the forest warden. Patrol means prevention, for usually the officer who patrols prevents as many fires as he extinguishes. By traversing the forests under his charge during excessively dry weather, the patrolman is often not only able to detect and extinguish fires before they get beyond control, but the likelihood of his presence at any place will in all probability deter many who might otherwise either carelessly, negligently, or intentionally start fires. Patrol is such an important part of modern forest fire prevention that the Federal Government stipulates that the money expended by it in coöperative fire protection with the various States must be spent to a large extent in the employment of patrolmen and lookouts.

Patrol is now practiced wherever effective fire protection is attempted. The new State law requires the forest wardens to patrol during dry and dangerous seasons, and, in addition, gives the State Forester full power to establish and direct such patrol whenever in his judgment this is advisable or necessary. By referring to Table 1 it will be seen the "dry and dangerous seasons" are most likely to occur in spring and fall, and it is in these two seasons that most of the patrol work would be carried on. However, local conditions or exceptional seasons might make it necessary to establish patrols at any time of the year.

By virtue of a coöperative agreement recently (June 9, 1915) entered into between the State Geological Board and the United States Department of Agriculture, a number of patrols will be established in the mountainous parts of the State during the fall fire season of 1915, and each fire season thereafter, as long as the arrangement continues. These men will be State Forest Wardens. They will work under the direction of the State Forester, but will be paid by the United States Government. Honest, energetic, intelligent men are required for this work; men who are familiar with the region which they will have to patrol, who have done woods work and have had experience in fighting fire.

The Power of Arrest.

No law can be effective unless it is enforced. The great weakness of the old law against burning the woods was that there was no special system of enforcement. The present law provides that system, and it must be made as effective as possible.

It is well known that many of our worst fires are of incendiary origin. They are started by irresponsible and often vicious men, who are determined to injure their neighbors, or even one particular neighbor, or else are indifferent to the loss sustained by property owners and the community at large. Experience has shown that it is usually very difficult to apprehend such offenders, because they operate in wild, uninhabited country, and often at night. It would be folly to employ men to prevent forest fires, require them to find out who started the fires, and then, when they come up with the offender, compel them to return many miles for the purpose of securing a warrant for the arrest of such offender. It is difficult enough to find the man who burns the woods, but it would be next to impossible to make arrests if such a procedure were required. It has, therefore, always been found necessary to give forest wardens the power of deputy sheriffs, namely, the power to arrest without a warrant those caught in the act of violating the law. This power is not likely to be abused, for it is the policy of the forest warden service to maintain the closest relations of fairness and good-will with all the law-abiding citizens of the district. A forest warden who presumed to misuse his power in this direction would at once be complained of so bitterly that his removal would be accomplished without delay. The whole object of the present law is to prevent and extinguish forest fires, and all other motives must and will be strictly excluded from the operations of the law.

Assistance in Fighting Fires.

The power to summons necessary assistance for fighting fires is given to forest wardens and a small penalty provided for refusal to serve. This means that unless some reasonable excuse can be given for declining to assist in extinguishing fires the persons summoned will be liable to a fine. If a reasonable excuse should be given, and the forest warden should decline to accept such excuse—a contingency hardly likely to occur—the justice of the peace before whom any action would come would undoubtedly decide that such excuse was valid and that the warden was not justified in declining to accept it. This adequately safeguards the power of summons.

Compensation of Forest Wardens.

One of the most frequently advanced arguments against State forest protection has been that by employing men to extinguish fires they were being induced to set out fires in order that they might be reimbursed for extinguishing them. Perhaps the simplest answer to such an argument is that only the worst men in a community would attempt such a

practice, and that the forestry law contemplates the employment of the best men in the community. It would be a poor policy indeed for any forest warden to attempt such a practice, because there are always a large number of people ready to report any failure in duty of a State employee. It is certain that any forest officer who attempted such a thing would get dismissed without delay. On the other hand, should some irresponsible party attempt to practice firing the woods in order to secure employment under the forest warden, the warden would be quick to suspect and discover any such criminal practice. Where such laws are enforced there has been little or no trouble from this source, though the same argument has been advanced against the operation of a like provision of law in nearly every State where it has been tried.

It has occasionally been urged that it is useless to pay men for fighting fires, because in many communities any number of men could be found in an emergency to fight fires without compensation. It would not only be unfair to the citizens of the community to expect them to carry on this most exhausting work without pay, but it would be exceedingly ineffective and would defeat the object of the law. The function of fire protection is to prevent fires rather than to extinguish them. That is, fires should not be allowed to start; and if they do get started, they must be put out before they become large fires. The first rule for the fire fighter is to get to the fire as soon as possible. A small fire is more easily extinguished and does infinitely less damage than a large fire. Now, only the large fire offers sufficient inducement for the average man to leave his regular work and go out and spend half a day or a whole day fighting to stop its advance. A small fire is apt to be neglected in the usually vain hope that it will burn itself out or some one else will extinguish it. The State cannot afford to risk such haphazard methods:

ADDITIONAL PROTECTION TO CITY WATER SUPPLIES.

The State Geological and Economic Survey has consistently advocated the effective protection from fire of the forested watersheds of cities and towns. It has stood and still stands ready at any time to examine such areas with the object of recommending methods for protecting them from forest fires and consequent contamination.

A number of such examinations have already been made and reports submitted. Two such reports have been published, those for Marion and Asheville.*

Following the suggestions contained in these reports, and especially in a letter written by the State Forester and published in the *Asheville*

*See Biennial Reports of the State Geologist, 1909-10, p. 86, and 1911-12, p. 57.

Gazette-News, as well as in editorial comments by that paper, Senator Weaver of Buncombe drew up and introduced into the General Assembly of 1913 a bill which is now one of our important forestry laws.

THE LAW FOR THE PROTECTION OF CITY WATERSHEDS.

The following law, while only applying to municipal watersheds, has an important and increasing usefulness in this State, because of the recent rapid development of the forested watershed idea:

AN ACT TO PROTECT WATERSHEDS OWNED BY CITIES AND TOWNS FROM DAMAGE BY FIRE.†

The General Assembly of North Carolina do enact:

SECTION 1. That any person, firm, or corporation owning lands or the standing timber on lands within 400 feet of any watershed held or owned by any city or town, for the purpose of furnishing a city or town water supply, upon cutting or removing the timber, or permitting same to be cut or removed, from lands so within said 400 feet of said watershed, or any part thereof, shall, within three months after cutting, or earlier upon written notice by said city or town, remove or cause to be burned, under proper supervision, all tree-tops, boughs, laps, and other portions of timber not desired to be taken for commercial or other purposes within 400 feet of the boundary line of such part of said watershed as is held or owned by such town or city, so as to leave such space of 400 feet immediately adjoining the boundary lines of such watershed so held or owned free and clear of all such tree-tops, laps, boughs, and other inflammable material caused by or left from cutting such standing timber, so as to prevent the spread of fire from such cut-over area and the consequent damage to such watershed.

SEC. 2. That any such person, firm, or corporation violating the provisions of this act shall be guilty of a misdemeanor.

SEC. 3. That this act shall be in force from and after its ratification.

Ratified this the 6th day of March, A. D. 1913.

Pure water means health. A protected watershed insures unpolluted water. An abundant supply of pure water is the best advertisement a city can have. To secure and maintain such a supply is the best investment a city can make.

Many cities and towns in North Carolina own their own "catchment areas" or watersheds; others secure their water from small streams whose drainage area is owned by private individuals. In both cases the State insists that certain general precautions be taken by the city authorities to prevent pollution of their waters, and monthly inspection patrol is insisted upon for this purpose.

The most obvious and most effective measure to prevent pollution of streams, namely, the protection of the woodlands on their watersheds

†Chapter 56, Public Laws 1913.

from fire, has until very recently received no attention from the State, and only in certain noteworthy instances, particularly those of Asheville and Marion, from the municipal authorities themselves.

A bare, hard soil surface, such as is left by burning the woods, allows the rainfall to collect and run directly to the streams, carrying with it small particles of soil, decaying vegetable or animal matter or other material, often laden with typhoid and other disease germs. If, however, the woods are protected from fire, there will be a good coat of leaves on the ground, held together by grass, weeds, and bushes. This makes an absorbent cover to the soil which acts as a sponge, soaking up the rain as it falls and at the same time keeping the soil soft and permeable so that the rainfall will nearly all of it be soaked into the ground. In this way all impurities are filtered out, and the springs are supplied regularly with clear, pure water.

The movement for more complete control by cities and towns of their water supplies has grown very rapidly in North Carolina. At the 1915 session of the Legislature a number of our mountain towns secured the necessary permission to purchase or enlarge their watersheds, Waynesville, Asheville, Hendersonville, Tryon, and Old Fort being among them. These municipal forests must be protected from fire as well as from other dangerous and deleterious influences. Municipal authorities should see that this law is enforced wherever it is applicable. In addition, they should assist the responsible officers in every possible way in the strict enforcement of the general forest fire law.

Watersheds on which part or all of the land is in private ownership may have to be further protected by the enactment of a law to prohibit parties burning over even their own land. Possibly, however, the State Board of Health has already sufficient power to control this.

LAWS FOR THE CREATION OF STATE FORESTS.

NEED FOR DEMONSTRATION IN FORESTRY.

Two-thirds of the land area of North Carolina is in woods and only one-third is cultivated. The woodland, however, yields a much smaller revenue to its owners than does the cleared land. Why? Is it not, at least in part, because we bestow so little thought and labor on the two-thirds which is in forest? No one will work in the woods unless he gets immediate returns in the form of sawlogs, ties, cordwood, etc. Yet much forethought and labor without direct result is expended on the cultivated land. Is it not worth while to know how such forethought and work can be made to increase the value and yields of two-thirds the total area of the State? How has our State Government set about improving

agriculture in North Carolina? Not only by publishing bulletins, instructive but all too little read; not only by providing for talks at farmers' institutes; it is not even satisfied with providing splendid colleges and high schools where young men can be taught both the theory and practice of agriculture. But our active and progressive Department of Agriculture has purchased seven test farms in different regions of the State, where crop varieties are grown, and where it is shown which varieties and what methods are most suitable for certain soils and climates. In addition to these and in a way combining the college and the test farm, farm-life schools are being established in nearly every county in the State. But the arguments which above all else bring home to the adult farmers the possibility, even the necessity, of practicing better methods are brought out on the demonstration plats maintained by the Department of Agriculture, and the demonstration crops supervised by State and county demonstration agents.

Does not this suggest the value of State experiment and demonstration forests in carrying out a forest policy for the State? The Department of Agriculture has set a precedent which the Forestry Department should not only be allowed, but required to follow.

THE LAW GOVERNING THE ACQUIREMENT AND ADMINISTRATION OF STATE FORESTS.

The following law, passed at the recent session of the Legislature, is the first step in the inauguration of such a policy. While it does not provide funds for the purchase of forest lands, it does recognize the principle of State experiment and demonstration forests, and places the authority to purchase such forests, when money for that purpose may be available, with a responsible and competent department of the State Government. It also provides that State forests may be organized and administered without any further legal enactments, where gifts of land can be secured for this purpose.

AN ACT TO ALLOW THE ACQUIREMENT BY THE STATE OF STATE FORESTS.*

The General Assembly of North Carolina do enact:

SECTION 1. That the Governor of the State is authorized, upon recommendation of the Geological Board, to accept gifts of land to the State, the same to be held, protected, and administered by said board as State forests, and to be used so as to demonstrate the practical utility of timber culture and water conservation, and as refuges for game. Such gifts must be absolute except in such cases as where the mineral interest on the land has previously been sold. The State Geological Board shall have the power to purchase lands in the name of the State, suitable chiefly for the production of timber, as State

*Chapter 253, Public Laws 1915.

forests, for experimental, demonstration, educational, park, and protection purposes, using for such purposes any special appropriations or funds available. The Attorney-General of the State is directed to see that all deeds to the State of land mentioned in this section are properly executed before the gift is accepted or payment of the purchase money is made. Said State forests shall be subject to county taxes assessed on the same basis as are private lands, to be paid out of moneys in the State Treasury not otherwise appropriated.

SEC. 2. That all moneys received from the sale of wood, timber, minerals, or other products from the State forests shall be paid into the State Treasury and to the credit of the Geological Board; and such moneys shall be expended in carrying out the purposes of this act and of forestry in general, under the direction of the Geological Board.

SEC. 2½. That nothing in this act shall operate or be construed as authority for the payment of any money out of the State Treasury for the purchase of lands or for other purposes unless by appropriation for said purpose by the General Assembly.

SEC. 3. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 4. That this act shall be in force from and after its ratification.

Ratified this the 9th day of March, A. D. 1915.

Though this is a new departure for North Carolina, it is by no means a new idea, as State experiment and demonstration forests have been consistently advocated by the North Carolina Geological and Economic Survey for a number of years (see Economic Paper No. 22, p. 42; Press Bulletins Nos. 130, 142, 145). A number of States to the north and west of us are now operating such forests. The Forestry Committee of the Fifth National Conservation Congress reported two years ago a total of sixty-three State forest experiment stations in eleven States, more than three-quarters of them being in the two States of Pennsylvania and Ohio. In some cases regular State forests, or parts of them, are used as experiment forests, while in other cases separate and smaller areas are procured. Ohio, for example, has fourteen experiment forests and no State forests, while Michigan has fifty-two State forests and only one experiment forest. However, all organized and administered State forests cannot help but be demonstration forests to a greater or less extent, because they show to the citizens how the State manages its own forest lands. Whether these are managed in the right or wrong way depends on the knowledge and money available, and the knowledge depends, at least in part, on experiments which should be made on those or similar forest areas.

Gifts of Land for State Forests.

There are, no doubt, many public-spirited citizens of North Carolina who, if they realized the need for demonstration and experiment forests,

• would gladly give to the State enough forest land to adequately serve such a purpose. Not only is low-priced land suitable for this purpose, but valuable land is most unsuitable. Agricultural land is not wanted, though a small percentage of such might be included in the place. What is needed is to show how forest which is to remain in woods should be managed. There is land in nearly every county which will pay better to keep in woods than to clear. This is certainly worth less to the owner than the average land in the neighborhood. At the same time it would suit forest demonstration purposes better, because it is absolute forest land, *i. e.*, land which should remain permanently in woods.

Demonstration forests, however, should be accessible. As their chief use is to show by actual practice what can be done in forestry, they should be where as large a number of people as possible can see them; for instance, near a main line of railway or on an improved and well traveled highway.

Again, they must contain fairly average samples of at least one important type of forest of the region, and if possible all the important types should be represented. For instance, a demonstration forest in the eastern piedmont region should have some hardwood and pine forest, some old-field pine, and some pure hardwood forest, with a fair representation of most of the important timber trees of the region.

Purchasing State Forests.

The above law provides for two other methods of securing State forests besides by gift. The State Geological Board is allowed to purchase State forests either with money specially appropriated by the General Assembly for the purpose or with other funds which may be available. Section 2½ is designed to make clearer the purpose of this provision. It says that money cannot be withdrawn from the State Treasury for the purchase of land without special appropriation by the Legislature. However, when such appropriation is made the Geological Board cannot only purchase land, but it can administer it as a State forest; protect it from fire and trespass; do necessary cutting and thinning; plant trees or sow seed; dispose of surplus timber or other products, and make experiments in improved forest management.

Specific instructions as to the management and care of such land are not necessary in bills appropriating money to buy State forests, because general permission to properly administer them is given by this present law.

The State Geological Board is also allowed to purchase State forests "for experimental, demonstration, educational, park, and protection purposes," using any funds available. There is not likely to be very much

of the regular appropriation for the work of the Board available, but the Board is able to accept subscriptions or donations of money from private individuals or organizations for the purpose of buying State forests. In fact, this is clearly contemplated by law. A State forest of a few hundred or even thousand acres would be a worthy monument to any individual or event. Why should not one or more of North Carolina's patriotic and public-spirited organizations take the lead in a movement to accumulate funds for such a purpose? Will not Mount Mitchell State Park be a nobler and more enduring monument to Dr. Elisha Mitchell than any one which could be erected to him in metal or stone? There is room in this State for a number of such monuments, and the permanent benefit from their establishment would be incalculable.

SOME PROBLEMS TO BE SOLVED.

Some idea of the variety of questions which can be solved most satisfactorily by the State or National Governments can be gathered from the following quotation from Press Bulletin 142, "Demonstration Forests for North Carolina," North Carolina Geological and Economic Survey:

There are five principal forest regions in North Carolina, (1) The Spruce, (2) Mountain Hardwoods, (3) Piedmont Region, (4) Coastal Plain, (5) The Banks. Some of these can well be divided again into smaller subdivisions.

(1) The Spruce forests on the slopes of our highest mountains are of the greatest importance in regulating stream flow and for park purposes. Lumbering operations as at present practiced result in their total destruction. It will pay the State to demonstrate that lumbering can be done in these forests without such devastating waste. A State forest in this type could at the same time be used as a State park, and for the protection of the important mountain streams.

(2) The Mountain forests, which now contain the greater part of our old-growth hardwood supply, are being cut in such a way that the more valuable kinds of timber trees are rapidly disappearing. Landowners should be shown how to cut so that the proportion of the poplar, chestnut, linn, and other valuable species will be increased in the second growth, rather than diminished.

(3) The original growth pine has been so largely removed from what were the mixed hardwood and pine forests of the Piedmont region that the second growth now consists almost entirely of the much slower growing oak. How best to increase the proportion of young pine timber in these woods is a problem which can be decided by experiment, and can then be conclusively shown by demonstration.

(4) The rehabilitation of our once large turpentine industry depends on second-growth long-leaf pine. This tree has been practically exterminated over large areas, and little effort is being made to bring it back, even in the districts best suited to its growth. Experiments on the ground would show that much so-called waste land could profitably produce long-leaf pine.

(5) "The Banks" and similar areas along our coast were originally covered with forests. Now they are mostly bare sandy wastes. The best methods of reforesting them and making them permanently productive, and at the same time stopping the ceaseless drifting of the sand, can only be shown by doing actual work in reforestation on the ground.

These and many other just as important problems in forest management and forest protection have to be solved to the satisfaction of the people of North Carolina, and *this can best be done by the State on State-owned forest land.*

FURTHER BENEFITS OF STATE FORESTS.

While the most important use of State forests is their educational value through demonstration and experimentation, they have several other uses, any of which in itself is generally considered sufficient excuse for their creation, and, added to the primary object, double their value to the State.

(a) *Protection Forests.* A forest covering a city watershed or lying on the headwaters of a stream or on a steep mountain slope serves as a protection against muddy or polluted water or against floods and extreme low water. Such forests should be publicly owned and controlled by the Nation, State, or municipality as protection forests. Asheville, Marion, and other of our towns own such forests, and the Federal Government is purchasing the Appalachian National Forests with this object primarily in view. All the spruce and balsam forests in North Carolina should be publicly owned, if only for this one reason.

(b) *Park Forests.* There are areas in all States which are noted for their scenery, extensive views, grand waterfalls, beautiful trees, rugged cliffs or gorges. The forest forms such an integral part of the attractiveness of such places that their value would be destroyed by its removal. Such natural monuments seem to belong by right to the whole people, and they should be preserved intact. Even though now in private ownership, they should be acquired and preserved by the State for the pleasure, health, and recreation of its citizens and for generations yet to come, all of whom have an actual interest in their perpetuation.

MOUNT MITCHELL STATE PARK.

It was primarily for the two above reasons, as set forth in its preamble, that the General Assembly passed the bill to purchase the top of Mount Mitchell as a State park. This project has been strongly advocated by the North Carolina Forestry Association and has been consistently urged by the State Geological and Economic Survey. (See Press Bulletins Nos. 100, 119, 135, and 138.) The measure was ably championed by Governor Craig and was indorsed by the Asheville Board of Trade and many other similar bodies. The bill was introduced into the General Assembly by Senator Zebulon Weaver of Buncombe, who, two years earlier, had proposed a similar measure. It received the strong support of a number of influential men in both houses of the Legislature, and was passed in the House by a majority of 67 to 32.

THE MOUNT MITCHELL PARK PURCHASE LAW.

The following is a copy of the law authorizing the purchase of the summit of Mount Mitchell:

AN ACT TO APPOINT A COMMISSION TO ACQUIRE A PORTION OF MOUNT MITCHELL, INCLUDING THE SUMMIT, AND TO PROVIDE FOR THE CREATION OF A PUBLIC PARK FOR THE USE OF THE PEOPLE OF THE STATE OF NORTH CAROLINA.*

Whereas the summit of Mount Mitchell in Yancey County is the greatest altitude east of the Rocky Mountains; and whereas the headwaters of many of the important streams of the State are at or near the said summit, and the forest is being cleared, which tends to damage and injure the streams flowing through the said State from the mountains to the Atlantic Ocean; and whereas it is deemed desirable that this beautiful and elevated spot shall be acquired and permanently dedicated as a State park for the use of the people of the entire State seeking health and recreation; and whereas, unless the said land is acquired by the State at this time, the cost of acquiring it at a later date will be greatly increased and the water-courses may be damaged and the beauty of the scenery destroyed by removing the growth therefrom, and irreparable damage accrue: Now, therefore,

The General Assembly of North Carolina do enact:

SECTION 1. That a commission is hereby created, to consist of five practical business men who shall be appointed by the Governor, and which shall carry out the provisions of this act and shall be known as the "Mitchell Peak Park Commission."

SEC. 2. That said commission shall be and is hereby created a body politic and corporate under the name and style of the "Mitchell Peak Park Commission."

SEC. 3. That the said commission shall have the power to fix the time and place of its meeting. Said commissioners shall hold office until the property hereinafter described shall have been purchased and a deed made to the State of North Carolina and until they shall have made a report of the same to the General Assembly and shall have been discharged. In the event of the death or resignation of any member of said commission, his successor shall be appointed by the Governor. The said commissioners shall receive no compensation but their traveling expenses, including hotel bills, while actively engaged in the work of said commission, and these expenses shall be paid out of the funds hereinafter provided for: *Provided*, that the said commission shall under no circumstances expend or contract to expend a greater amount than that named in this act for the purchase of said land.

SEC. 4. The said commission shall convene as soon as practicable and elect a chairman. The said chairman shall from time to time draw a warrant or warrants upon the treasurer of the State, which, after being approved and countersigned by the Governor and two other members of the commission be-

*Chapter 76, Public Laws 1915.

sides the chairman, shall be paid by the said treasurer to the owner of said lands purchased for the said purpose out of any funds not otherwise appropriated.

SEC. 5. The total amount to be expended under this act shall not exceed \$20,000, and the said sum of \$20,000 is hereby designated as a maximum amount to be expended in the acquisition of the said properties, and the said commission is especially charged with the duty of acquiring as much of the lands as is possible for the purpose intended, not exceeding the maximum amount hereinbefore designated.

SEC. 6. Out of the funds so appropriated the said Mitchell Peak Park Commission shall have power, as soon as practicable, to acquire either by purchase or condemnation so much of Mount Mitchell, including the peak thereof, as they shall deem necessary as a suitable site for the purpose intended, and in the event of the purchase of said land or lands privately from the owner or owners thereof, the said commission shall take a deed to the State of North Carolina therefor.

SEC. 7. Whenever from any cause the said commission cannot agree with the owner or owners of the land which they shall select for the purpose of the park as aforesaid, as to the price to be paid for the same or for any part thereof, said land or lands may be taken at a valuation to be made by three competent and disinterested freeholders of the county of Yancey, one of whom, after due notice to the landowner of such proceedings, shall be chosen by the said commission, one selected by the landowner, and these two shall select a third; and in case the landowner refuses to select, then said commission shall select two and these two shall select a third, and said freeholders after being duly sworn by a justice of the peace of the county of Yancey, shall at once go on said land and proceed to condemn said land or lands and ascertain the sum which shall be paid the owner or owners of said properties and report the same to the said commission, under their hands and seals, which report, on being confirmed by the said commission and spread upon their minutes, shall have the effect of a judgment against the said Mitchell Peak Park Commission, and upon paying said sum to the landowner, or in the event of an appeal, upon paying said sum to the chairman of said commission to await the result of such appeal, shall pass title to the State of North Carolina of the land so taken: *Provided*, that if any person whose land is taken for the said purpose or the said commission be dissatisfied with the valuation thus made, then and in that case either party may appeal to the next term of the Superior Court of Yancey County within ten days from the filing of such report: *Provided further*, that such appeal shall not hinder the commission from taking possession of said property.

SEC. 8. The Governor shall have power, upon complaint or upon his own motion, to remove any of said commissioners for negligence of duty or for any conduct unbecoming said commissioner and inconsistent with his duties under this act. The position of commissioner under this act shall not be construed to be an office within the meaning of section 7, Article XIV of the Constitution of North Carolina. The said Mitchell Peak Park Commission shall make report to the Governor, setting forth all purchases, condemnations, and expenditures of every kind under this act.

SEC. 9. This act shall be in force from and after its ratification.

Ratified this the 3d day of March, A. D. 1915.

Fire Protection Needed.

It will be seen that this bill provides only for the purchase of the land. Its weakness seems to be that no provision is made for the protection of the land from fire both during and subsequent to its acquisition. Since logging operations commenced two years ago, the forest areas which it is planned to buy have been constantly threatened with destruction, and several times fire has come upon the southern slope of the mountain. Fires at any time are liable to destroy hundreds of acres of these spruce forests, and, once destroyed, the beauties of the park would be gone. There is immediate need for some adequate system of fire protection for the Mount Mitchell State Park. Fortunately, special arrangements are now under consideration, and it is hoped that before fall effective protection can be given at least the part of this mountain which is to be purchased by the State. It would be most appropriate that the very first State protection furnished by North Carolina should be given to historic Mount Mitchell.

The Commission.

The Mitchell Peak Park Commission provided for by this law was appointed by the Governor on March 31. It consists of the following gentlemen, all of them from regions vitally concerned in the purchase of the park, and all but one from Yancey, the county in which Mount Mitchell is situated:

Mr. T. E. Blackstock, Asheville, N. C.
Mr. G. P. Deyton, Green Mountain, N. C.
Mr. E. F. Watson, Burnsville, N. C.
Mr. M. C. Honeycutt, Burnsville, N. C.
Mr. Wilson Hensley, Bald Creek, N. C.

This commission met in Burnsville Saturday, April 10th, and organized by electing Mr. T. E. Blackstock chairman and Mr. M. C. Honeycutt secretary. A second meeting was planned to take place in May on the top of Mount Mitchell, with the object of securing local information in regard to the different properties which are being considered for purchase under the law.

APPALACHIAN NATIONAL FORESTS.

The Federal Government cannot purchase or acquire control of land in any State without the permission of that State. It was therefore necessary, when the people were asking that National forests or parks be established in western North Carolina, that the State grant the Government the right to make such purchases. The following law was

passed by the General Assembly of 1901, at the beginning of the agitation for the Appalachian Park and just ten years before the Federal law taking advantage of this permission was finally enacted. (See Press Bulletin 147, Forestry Laws of North Carolina, Appendix.)

LAW TO ALLOW FEDERAL ACQUIREMENT.

5430. *Forest reserve, western Carolina.* *The United States is authorized to acquire by purchase, or by condemnation with adequate compensation, except as hereinafter provided, such lands in western North Carolina as in the opinion of the Federal Government may be needed for the establishment of a National Forest Reserve in that region. This consent is given upon condition that the State of North Carolina shall retain a concurrent jurisdiction with the United States in and over such lands so far that civil process in all cases, and such criminal process as may issue under the authority of the State of North Carolina against any person charged with the commission of any crime without or within said jurisdiction, may be executed thereon in like manner as if this consent had not been given. Power is hereby conferred upon the Congress of the United States to pass such laws as it may deem necessary to the acquisition as hereinbefore provided, for incorporation in such National forest reserve such forest-covered lands lying in western North Carolina as in the opinion of the Federal Government may be needed for this purpose, but as much as 200 acres of any tract of land occupied as a home by *bona fide* residents in this State on the 18th day of January, 1901, shall be exempt from the provisions of this section. Power is hereby conferred upon Congress to pass such laws and to make or provide for the making of such rules and regulations, of both civil and criminal nature, and to provide punishment therefor, as in its judgment may be necessary for the management, control, and protection of such lands as may be from time to time acquired by the United States under the provisions of this section.

Acquirement by Purchase Only.

In a few localities in western North Carolina considerable opposition to the National Forest Reserve policy was at one time developed, based largely on a misunderstanding of the conditions on which the land was to be procured. The above State law allows the United States to acquire land "by purchase, or by condemnation with adequate compensation." From this permission the idea gained ground that the Government would condemn land and take it whether the owner wished to sell it or not. This is permitted under the State law, provided "adequate compensation" is made. But the Federal law under which Appalachian forest lands are acquired stipulated "that the Secretary of Agriculture is hereby authorized to *purchase*," and no other method of securing these lands is mentioned in the whole law. There has been no thought

*Chapter 118, section 5430, Revisal 1905.

of employing condemnation proceedings such as are allowed by the State law and as are actually to be put in practice by the Mitchell Peak Park Commission,[‡] if it is found necessary to do so.

It is true, that in order to secure a clear title to land which is owned by a number of different claimants who have not only expressed a willingness to sell, but have agreed upon a price, the Government has in certain cases brought condemnation proceedings in court. These are nothing but friendly suits to determine the real ownership of the lands and the proper share of the price each claimant is entitled to. It is a proceeding all business men are familiar with, and can be objected to by no one.

It will be noticed that in all dealings with the Federal Government the rights and privileges of the State are jealously guarded. Not only does the State Legislature clearly define the powers which it delegates to the United States, but Congress clearly stipulates in the law allowing the purchase of land that no land shall be bought in any State which has not previously given its consent thereto.[‡]

PROTECTION OF GAME ON NATIONAL FORESTS.

It is with the same scrupulous care to maintain the most cordial relations with the State of North Carolina and avoid any possible cause of friction that permission was asked by the Federal Government to make and enforce regulations for the protection of animal life on the Appalachian National Forests. It might seem that such power was conferred upon Congress by the law allowing the United States to buy lands (page 43), but this was not considered specific enough. In accordance, therefore, with its policy, the Government of the United States asked permission to make such rules and regulations as were thought needful "in respect to game animals, game and nongame birds and fish" on Federal lands in the western part of North Carolina.

LAW TO ALLOW FEDERAL PROTECTION OF WILD LIFE.

The permission requested by the Federal Government was granted by the General Assembly of 1915 in the following law:

[‡]See page 41.

AN ACT TO GIVE THE CONSENT OF THE STATE OF NORTH CAROLINA TO THE MAKING BY THE CONGRESS OF THE UNITED STATES, OR UNDER ITS AUTHORITY, OF ALL SUCH RULES AND REGULATIONS AS IN THE OPINION OF THE FEDERAL GOVERNMENT MAY BE NEEDFUL IN RESPECT TO GAME ANIMALS, GAME AND NONGAME BIRDS, AND FISH ON LANDS, AND IN OR ON THE WATERS THEREON, ACQUIRED OR TO BE ACQUIRED BY THE FEDERAL GOVERNMENT IN THE WESTERN PART OF NORTH CAROLINA FOR THE CONSERVATION OF THE NAVIGABILITY OF NAVIGABLE RIVERS.*

Whereas the Government of the United States, with the consent of the General Assembly of the State of North Carolina, has acquired and will acquire areas of forested land in the western part of said State for the purpose of conserving the navigability of navigable streams, and said lands and waters thereon are and will be stocked, naturally and artificially, with game animals, game and nongame birds, and fish; and whereas, in order adequately to enjoy and protect the occupancy and use of said areas, it is important that the United States be fully authorized to make all needful rules and regulations in respect to such animals, birds, and fish: Therefore,

The General Assembly of North Carolina do enact:

SECTION 1. That the consent of the General Assembly of North Carolina be and hereby is given to the making by the Congress of the United States, or under its authority, of all such rules and regulations as the Federal Government shall determine to be needful in respect to game animals, game and nongame birds, and fish, on such lands in the western part of North Carolina as shall have been or may hereafter be purchased by the United States under the terms of the act of Congress of March 1, 1911, entitled "An act to enable any State to coöperate with any other State or States, or with the United States, for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purposes of conserving the navigability of navigable rivers" (36 United States Statutes at Large, page 961), and acts of Congress supplementary thereto and amendatory thereof, and in or on the waters thereon.

Ratified this the 9th day of March, A. D. 1915.

The people of North Carolina are coming to realize very acutely that our wild life needs protection quite as much as any other of our natural resources. The destruction of the food fishes of our streams by unrestrained and often unlawful fishing and by polluting the waters with sawdust or mill waste has reached alarming proportions. And when we come to think of it, what right has a man to deprive a neighborhood of one of the most delicious and healthful of foods in order that he may have 5 cents more per thousand feet of lumber on his sawing or a fraction of a cent more profit on his investment in some large manufacturing plant? The manufacturers of lumber, of leather, of paper, all do their

*Chapter 205, Public Laws 1915.

part towards the development of the community and the State, but we are beginning to realize that in prosecuting their business they have no right to trespass upon the rights of their neighbors.

Game birds in North Carolina have generally been looked upon in the light of the special property of the sportsman, and heretofore game laws have been passed chiefly for his benefit. We are now, however, coming to realize that the farmer, the owner of the land, has much more interest in the game which lives upon his land than has the man whose sole interest is killing it. To mention one instance of this, our common partridge or quail is worth to the farmer for destroying noxious insects a great deal more than it is to the sportsman or the hotel keeper. In the future our game laws must consider, first, the value of the living birds and animals to the landowner and the general public before it considers their value from the old standpoint of being something to kill.

ARBOR DAY.

The regular observance of Arbor Day in North Carolina has been strongly advocated by the State Geological and Economic Survey for a number of years. The first press bulletin on this subject ever issued by the Survey had the above title, and not only advocated the general observance of this day throughout the State, but suggested the adaptation of a program to the special conditions existing in North Carolina. As well as emphasizing the planting of trees, it was recommended that the attention of the children be called to the value of the forests of the State to the life of the average citizen. In the words of the author of the press bulletin above referred to, which was issued April 7, 1908, "It is to be desired that this day shall be more generally observed and that our young people shall be brought to a realization of the value of our forests and the beauty and need of trees for shade and decorative purposes. . . . How soon many of our school yards could be made places of beauty if on each Arbor Day the school would plant a certain number of trees or shrubs and then care for them during the year.

"While the same reasons for the observance of Arbor Day in the scantily forested western States cannot all hold in a well wooded State like North Carolina, yet the celebration here of such a day has its significance. Arbor Day in North Carolina could be set aside for the school children to learn of the great natural gift which we have in the forests, and the relation of the forest to the well-being and wealth of our people."

ARBOR DAY LAW.

An Arbor Day law such as is found on the statute books of practically half the States of the Union was introduced into the General Assembly

of 1913. It, however, failed of passage, owing to the rush of bills at the end of the session. A similar bill was introduced into the Legislature of 1915, and, backed by the good people of Charlotte (who had previously held a most successful Arbor Day celebration in that city), by the North Carolina Forestry Association, the State Geological and Economic Survey, and others interested in Forestry, it became a law without any serious opposition.

AN ACT TO APPOINT AN ARBOR DAY FOR NORTH CAROLINA.*

The General Assembly of North Carolina do enact:

SECTION 1. That the Friday following the first day of November in each year shall be known as Arbor Day, to be appropriately observed by the public schools of the State.

SEC. 2. That the Governor is herewith authorized to make proclamation setting forth the provisions of this act and recommending that Arbor Day be appropriately observed by the school children of the State, in order that they may be brought up to appreciate the true value of trees and forests to their State.

SEC. 3. That it shall be the duty of the State Superintendent of Public Instruction to take the matter of the observance of Arbor Day by the public schools of the State under his general supervision, to issue each year a program for its observance, to cover such part of the day as he may prescribe, and to transmit suitable instructions to the county school authorities under his charge for an appropriate observance of Arbor Day.

SEC. 4. That this act shall be in force from and after its ratification.

Ratified this the 25th day of February, A. D. 1915.

At first thought, it would seem that Arbor Day should be celebrated in the spring. The planting of trees and shrubs and the general call of the out-of-doors appeals to children much more strongly in the spring than in the fall. Many kinds of trees do better planted just before the sap starts in the spring than if planted in the autumn. It is for these and other reasons that most States keep Arbor Day in the spring, endeavoring to select a date upon which planting would be most likely to be successful. In many of the Southern States, however, the public schools are not in session in the spring; so that it is impossible to have the day generally observed by the schools at that time of the year. It is for this reason that several States observe Arbor Day in the fall. Two or three have two Arbor Days a year, one in the spring and one in the autumn. Kentucky, which originally appointed a spring day, has found it necessary to change to November.

For this same reason it was thought advisable, after consultation with the North Carolina school authorities, to fix a day when practically all schools in the State are in session. It is hoped that this will insure

*Chapter 51, Public Laws 1915.

the observance of Arbor Day throughout North Carolina. The selection of Friday as Arbor Day was made by the public school authorities in order that the exercises would break into the regular school curriculum as little as possible.

Manner of Observance.

It is the custom in most States where Arbor Day is observed for the Governor to issue a proclamation calling the attention of the people to the advantages of observing the day with tree planting, decorating school grounds and home grounds, and studying the relation of trees and forests to the life of the people. Governor Craig has expressed his approval of this practice by indorsing this same provision in the North Carolina law. The law expressly authorizes the Governor to make the proclamation, but it does not require it. Whether, therefore, the proclamation is made or not, the validity of the observance will be the same, but the active participation of the Chief Executive in this way would add interest and enthusiasm to the occasion.

The State Superintendent of Public Instruction, who assisted in the preparation of the bill and has, since its passage, expressed his entire agreement with its provisions, will, as provided by the law, issue a program and instruct the school authorities to observe the day in the proper manner. Already several suggestions for Arbor Day celebrations have been published by the various State departments, and these may be referred to for assistance. Two years ago the Department of Education, assisted by the State Geological and Economic Survey, prepared an Arbor Day program and made other suggestions for the observance of the day. (See Civic Days: Good Roads, Arbor Day, pages 35-46, Bulletin XXII, N. C. Department of Education, 1913.). Last year the same department issued a program entitled "Community Service Week in North Carolina"; a few suggestions for improving school grounds by planting trees, which can be done on Arbor Day, will be found on pages 16 and 85 of that publication. Other references to Arbor Day observance in North Carolina can be found in Economic Paper No. 22, "Forest Fires and Their Prevention," and Press Bulletin No. 49, "Arbor Day in the North Carolina Schools." Some of the North Carolina towns have also published Arbor Day programs, notably Durham in 1896 and Charlotte in 1913. Many of the States issue annually handsomely illustrated Arbor Day bulletins or hand-books. In these are reprinted poems and other selections which can be recited by the school children.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesians Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Old Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, 1915. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents.*

25. Monazite, Zircon, and Other Minerals Used in the Production of Chemical Compositions Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt. *In press.*

ECONOMIC PAPERS.

1. The Maple-sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virginina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of

Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virginina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Prof. Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads Are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina During 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina During 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties, with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a List of Gems and Gem Minerals occurring in United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems occur, as taken from United States Geological Survey Report, by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin, and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos, describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin Mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31 and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey. Statistical Report of High-

way Work in North Carolina During 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and including the Issuing of the Drainage Bonds. Compiled by George R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina During 1914, and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of the Seventh Annual Drainage Convention held at Wilson, N. C., November 18 and 19, 1914. Compiled by Joseph Hyde Pratt. *In press.*

42. Proceedings of the Road Institute held at the University of North Carolina February 23-27, 1915. Compiled by Joseph Hyde Pratt. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking-waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county-seats in North Carolina; list of Magnetic Declinations at the county-seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the U. S. Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on forest fire conditions in the southeastern States, by J. S. Holmes. Report on the work of the U. S. Forest Service in North Caro-

lina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, post-office address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA COMMERCE AND ECONOMIC DEVELOPMENT

STUDY OF THE TRAFFIC AND COMMERCE

CONTINUING PAPER No. 10

PROCEEDINGS

SEVENTH ANNUAL DRAINAGE CONVENTION

NORTH CAROLINA DRAINAGE ASSOCIATION

WILSON, NORTH CAROLINA

DECEMBER 14 AND 15, 1933

APPROVED BY THE BOARD OF COMMISSIONERS

STATE OF NORTH CAROLINA



NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 41

PROCEEDINGS
OF
SEVENTH ANNUAL DRAINAGE CONVENTION

OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION

HELD AT
WILSON, NORTH CAROLINA
NOVEMBER 18 AND 19, 1914

COMPILED BY
JOSEPH HYDE PRATT, State Geologist
AND
MISS H. M. BERRY, Secretary



RALEIGH
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1915

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., August 1, 1915.

*To His Excellency, HON. LOCKE CRAIG,
Governor of North Carolina.*

SIR:—On November 18 and 19, 1914, there was held at Wilson, North Carolina, the Seventh Annual Convention of the North Carolina Drainage Association. Because of the magnitude which the drainage of our swamp and overflowed lands has reached in North Carolina, the value to this work of the papers and discussions given at this convention, and the close coöperation between the North Carolina Geological and Economic Survey and the Drainage Association, I recommend that these proceedings be published as Economic Paper No. 41 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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INTRODUCTION

Since the organization of the North Carolina Drainage Association in 1908, there has been close coöperation between its work and that of the North Carolina Geological and Economic Survey; and it was through the work of these two agencies that the North Carolina drainage law was drafted and passed by the Legislature of 1909 and amended by subsequent Legislatures. It is largely through the conventions of this Association that public opinion has been awakened to the immense importance to the State of the drainage of these wet lands, including both swamp lands of the coastal plain and overflowed lands of the Piedmont and mountain regions.

The work of organizing each convention has been done largely by the Geological Survey and for the Seventh Annual Convention the following letter was prepared and sent to the chairmen of the boards of county commissioners, asking them to appoint delegates to represent their respective counties; to the mayors of towns and cities for the appointment of delegates to represent their municipalities; to the presidents of boards of trade and chambers of commerce to represent their bodies; and to the commissioners of drainage districts already established for the appointment of delegates to represent their individual districts.

CHAPEL HILL, N. C., October 15, 1914.

DEAR SIR:—At Wilson, N. C., on November 18 and 19, 1914, will be held the Seventh Annual Convention of the North Carolina Drainage Association. I am extending to you a most cordial invitation to attend this Convention as a delegate, and will ask you to appoint ten delegates to represent your..... I will appreciate it if you will select men who are sufficiently interested in this work to attend the Convention and to take part in the proceedings. Send me their names and addresses so that they can be officially notified of their appointment. I sincerely hope that it will be possible for you to attend yourself, and that you will urge the delegates whom you appoint to attend.

Enclosed is a circular relating to the Reclamation of the Swamp and Overflowed Lands of the State which shows the work which has been done for drainage since the organization of our Association seven years ago. These data show that the drainage work of the State has assumed large proportions, and is meaning much to our people, not only from an economic standpoint in the reclamation of most valuable agricultural lands, but from the standpoint of health. Vast areas of eastern North Carolina, which, before drainage, were not only worthless, but were a menace to public health, are now yielding large revenues to this section and are being made desirable places for residence through the elimination of the malarial mosquitoes.

The drainage of the creek and river bottoms of Piedmont and western

North Carolina is also assuming large proportions, and is proving of inestimable value to these sections.

Trusting that you will coöperate with us in the appointment of delegates, and not only urge them to attend, but come yourself, I am, with best wishes,

Very truly yours,

JOSEPH HYDE PRATT, *President.*

The following letters of notification and information in regard to program, arrangements for delegates, etc., were mailed to all delegates appointed, and also to the members of the North Carolina Drainage Association:

CHAPEL HILL, N. C., October 24, 1914.

MY DEAR SIR:—This is to notify you that you have been appointed a delegate to the Seventh Annual Convention of the North Carolina Drainage Association, which will be held at Wilson, N. C., November 18 and 19, 1914. I sincerely hope you will be able to attend the Convention, and assist in making it the most successful Convention that has been held in the interest of the reclamation of our swamp and overflowed lands.

The drainage of our swamp and overflowed lands has progressed very satisfactorily, as is indicated by the enclosed circular, which will give you some idea of the magnitude of this work in North Carolina. The various problems that have come up in connection with this reclamation work will be considered and discussed at the Convention, and should be of interest to all those who are engaged in drainage work.

Another phase of this work that will be given a prominent place on the program is tile drainage.

Papers will be prepared by men who are experts in the various lines of drainage work, and after the papers have been read, they will be discussed, and all attending the Convention are cordially invited to take part in the discussions.

As we desire to have as large an attendance as possible at the Convention, in order that the various drainage problems may be more thoroughly considered, I will appreciate it if you will send me the names and addresses of any persons who are interested in drainage work, and who would like to attend as delegates.

Trusting to have the pleasure of seeing you at the Convention, and with best wishes, I am,

Yours cordially,

JOSEPH HYDE PRATT, *President.*

CHAPEL HILL, N. C., November 9, 1914.

MY DEAR SIR:—I sincerely hope that nothing is going to interfere with your being with us at the Convention of the North Carolina Drainage Association at Wilson, North Carolina, next week, November the eighteenth and nineteenth. This is a most important Convention, and we hope that every county and every section interested in the drainage of swamp and overflowed lands will have a large number of delegates present.

For the information of the delegates I would say that the headquarters of the Convention will be the New Briggs Hotel, where the rates are \$2.50

without bath, and \$3.00 with bath, a day. Other hotels are the Imperial and the Seabrook, where the rates run from \$1.50 to \$2.00 per day.

The sessions of the Convention will be held in the City Building during the day and in the Courthouse at night.

We are expecting some very interesting speakers. Among them will be:

Hon. E. J. Watson, Commissioner of Agriculture, South Carolina.

Mr. H. M. Lynde, Drainage Engineer, U. S. Department of Agriculture, Washington, D. C.

Hon. John H. Small, Congressman from the First District.

Hon. B. E. Rice, Land and Industrial Agent of the Norfolk Southern Railway.

Hon. M. V. Richards, Land and Industrial Agent of the Southern Railway. Commissioner of Agriculture, Hon. William A. Graham.

Mr. C. W. Mengel, of the John L. Roper Lumber Company, and others.

One of the subjects which will be taken up in considerable detail is tile drainage. Also, the drainage law will be taken up and discussed and suggested amendments asked for.

Trusting that you will not only come, but interest others in your section, I am, with best wishes,

Yours very truly,

JOSEPH HYDE PRATT, *President.*

PROCEEDINGS
OF
SEVENTH ANNUAL DRAINAGE CONVENTION
HELD UNDER THE AUSPICES OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION AND NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
WILSON, N. C., NOVEMBER 18 AND 19, 1914

MORNING SESSION—Wednesday, November 18

The Seventh Annual Convention of the North Carolina Drainage Association was called to order at 10:30 o'clock in the opera house, Wednesday, November 18, by President Joseph Hyde Pratt.

The Convention was opened with prayer by Rev. T. W. Chambliss, pastor of the Baptist Church:

Our Heavenly Father, we thank thee for the privilege of living in this age. We thank thee for the opportunity of building greater things in thy name and for thy glory. We praise thee for the blessings which have come upon us in the passing years. We thank thee at this time that the spirit from thy throne seems to direct our nation and that we are at peace.

We come to thee this morning, as we assemble here, to discuss larger measures to benefit the people of our State, and we ask thy blessing and thy guidance, praising thee for the privilege of thy being with us in the upbuilding of the commonwealth. We ask thee, O Lord, that all we do, all that we accomplish, and all of our plans and creeds shall be to thy glory and to the upbuilding of a nation to thy name; and we ask it in the Redeemer's name. Amen.

Addresses of Welcome

Following the prayer, Mr. Lawrence Brett, in the absence of Mr. O. P. Dickinson, mayor of Wilson, made an address of welcome on behalf of the city of Wilson, as follows:

Mr. Chairman and Members of the Convention:

I have been asked by Mr. O. P. Dickinson, Mayor, to extend his hospitality, as Mayor of the town, to this Convention. Mr. Dickinson is engaged this week in court, and it is impossible for him to leave at this hour. Dr. Dickinson wishes me, on behalf of the Town of Wilson, to extend a very cordial welcome to this, the Seventh Annual Convention of the North Carolina Drainage Association.

On behalf of the Chamber of Commerce I wish also to extend a hearty welcome. If the weather had not turned quite so cold I was going to say that I would extend a very *warm* welcome, but the heating plant in this building being out of commission just at this time, we are not able to make it quite as warm this morning as we would like.

The people of Wilson are very deeply interested in the work of drainage. We have for several years had representatives attending the various drainage association meetings in the State, and in every place we have been well entertained and have had very profitable meetings. We hope to make this meeting one of the most successful of the series, and on behalf of the Chamber of Commerce of Wilson, and the Entertainment Committee, we wish to thank you for your presence, and we want to do for you all that we can to make your stay a pleasant one.

Wilson County extended a welcome to the delegates through Mr. W. F. Woodard, Chairman of the Board of County Commissioners:

Mr. President, and Members of the North Carolina Drainage Association:

It gives me peculiar pleasure to welcome you to our midst. I expected a speech of welcome to be made by our Mayor; therefore I have not prepared anything to say, but as chief executive of this county I give you a most hearty welcome to our midst.

It is peculiarly fitting that the North Carolina Drainage Association should meet with us here in Wilson County, in that we have probably the first drainage district established in North Carolina after the United States Department of Agriculture had added to its experiment station the department of drainage. About a mile from Wilson, on the Tarboro road, is located a canal that we have dug. This canal is about twelve miles long, extending from the Atlantic Coast Line Railroad to the Tolsnot Creek. The plans, profile and specifications for this canal were made by the United States Department of Agriculture. Mr. H. A. Kipp was the drainage engineer in charge. Mr. Lawrence Brett, who is an officer of this Association, contracted to do this work for us, and it was done satisfactorily in every respect. I hope you gentlemen will take the opportunity to visit this canal while you are here with us. Incidentally, while going to see this canal, cast your eyes to the left and look at the fine blue grass pasture you will see there—blue grass growing from seed sown on land practically without any preparation at all.

Gentlemen, the latchstring hangs on the outside, and all you have to do is just ask for what you want, and it is yours.

The response to the addresses of welcome was made by the President of the Association.

It is my pleasant duty to make the response to the addresses of welcome. I think it is very opportune that the Convention of the North Carolina Drainage Association has been called to meet here in Wilson at this time. As Mr. Woodard stated, the first drainage district actually established was in Wilson County—the Tolsnot Drainage District. Although there had been some drainage work started before the actual digging of the canal, yet the first drainage district organized was here in Wilson County. Since the law passed in 1909, five years of drainage work has been going on in North Carolina; and now, as you will see from the map on the wall, there are seventy-two drainage districts organized, or in the process of organization, in North Carolina, either in the swamp lands or the overflowed lands of the Piedmont section. Many of these districts have been completed and the land is now in cultivation.

I said it was rather opportune that we meet here, because there has come up in the last year particularly, one question or phase of the drainage work that needs to be solved and worked out, and I believe the people of North Carolina are looking to the North Carolina Drainage Association to help them solve that particular problem, and that is—making use of, or bringing into cultivation the lands after they have been reclaimed by drainage.

Now, as you compare the overflowed areas with the swamp areas and work out the percentage of land under cultivation in each section after being reclaimed, you will find that in the overflowed districts a very large percentage of the land, immediately after it has been reclaimed, is brought under cultivation; while in the swamp areas there is a very large area which remains uncultivated for some time after the district has been organized and the canals dug. Now the reason for that is that in the Piedmont district, where you have the overflowed areas, the lands are owned by small land-owners who cultivate the lands themselves; while in the swamp areas the lands are very often held by men who own large areas and the greater portion of their holdings are for sale and not for cultivation by themselves. That means that in the Piedmont district we are not looking for any one to come in and settle on these areas that are being reclaimed, while in the swamp areas we are looking for others to come in and settle, and take up the cultivation of these lands.

We are all very much interested—deeply interested—in this great European war, and it seems to me that it is going to have a direct bearing upon the development of our swamp lands here in North Carolina. That is, if we should take upon ourselves as an Association to try to work out a plan by means of which we can call the attention of the Belgians and others of the European nations who are accustomed to work land such as we have here in eastern North Carolina, to the opportunities here and try to interest them to come over and become home-seekers here in eastern North Carolina, and take up these areas of our reclaimed swamp lands. I do not believe we could find a better class of immigrants to try to bring into eastern North Carolina, for they would become good, substantial citizens of the State, especially the Belgians, and perhaps some of the families from Holland who have been accustomed to work reclaimed land and are doing intensive farming. They are also extremely expert in dairying and I believe a plan can be worked out by a committee appointed by the Association by which, in coöperation with other bodies, we can arrange to bring a considerable number of such people into eastern North Carolina. The start has already been made. I was in Georgia last week and in talking with the people of Atlanta, who have formed an organization there to take up the same question, they agreed to keep me posted as to what they accomplish, and I have agreed to keep them posted as to what we do in North Carolina, to see if we cannot send a delegation abroad and actually bring or induce those people, by telling them what we have, to come in and become a part of us in the development of the swamp lands of eastern North Carolina.

Mr. Woodard spoke of taking us out to see Toisnot Canal and the land that has been reclaimed, and what it is producing at the present time. He also stated that we had a perfect drainage law. It is perfect as far as it goes, and as perfect as the Legislative Committee that was appointed by the Association to draw it, could prepare it at that time, without ever having worked under

such a law. As you all know, that law was passed without a single amendment. Although twenty-nine amendments were introduced, they were all voted down, and the law was passed as drawn up by a committee of this Association. In 1911, after working under the old law for two years, the Legislative Committee found, after investigation, that certain amendments were necessary, and there were passed at the 1911 General Assembly those amendments to the North Carolina drainage law that were recommended by the Legislative Committee of this Association. Then they thought they had brought it up to what was as near perfect as possible. After two years' work on the law it was found that still other amendments were needed to make it more operative and to get better results. We were not quite so fortunate with the Legislature of 1913, and the amendments suggested by the committee were not passed. If the appropriation had been left out I think every amendment suggested would have passed, but it carried an appropriation, and I think the appropriation killed all the suggested amendments. However, I want to bring this point out: There was not a single drainage act passed by the General Assembly of 1913 that was not recommended by your committee; so that the influence of this Association, the North Carolina Drainage Association, is recognized by the people of North Carolina, and by the General Assembly. They realize that the men who are connected with it, and the men who are interested in the reclamation of the swamp and overflowed lands of North Carolina have given thought and study in every way as to what is the best law or legislation to pass to make the reclamation of these areas more effective.

Now, your Legislative Committee has been busy since the Legislature of 1913, and they will have certain recommendations to make to this Convention as to what they think should be passed by the General Assembly of 1915. The committee will also be in force and will meet during the sessions of the General Assembly and do whatever they possibly can to see that the recommendations of this Association are passed. I know that some of the delegates to this Convention have come up particularly to take up certain phases of legislation that they have found, in connection with the work in their districts, necessary to make the plans of carrying out the work of their section more effective.

One thing I do want to emphasize was the question of bringing under cultivation the lands after they have been reclaimed. I think you will all agree with me that there is no question now of stopping drainage work in North Carolina. I think both in the eastern North Carolina swamp areas and in Piedmont North Carolina that the work has gone to such an extent and has been so satisfactory that districts are going to be continually organized and the work carried on, but there is that question to take up now—the means by which we can bring under cultivation these lands after they have been reclaimed—and I think those who are interested in the large areas would like very much for this Association to take up more actively some plan by which such can be accomplished. I make the suggestion that during the business of this session we authorize the appointment of such a committee to take up that question.

There is one other thing that has come up during the past year in regard to our drainage work, which is similar to a problem we have in connection with roads: We have no trouble, or very little, in raising revenue for the

construction of roads. The main thing is to get the people of North Carolina to realize that after they have built the road they must have a revenue to maintain it and keep it in good condition. The same thing is true in regard to drainage districts. Do not let us make this mistake in regard to the maintenance of canals and ditches in drainage districts. Keep them clear so they will take care of the water. After building them, make provision for their maintenance.

Another thing has come up during the past year that I want to mention. As I stated before, there is no question now about the drainage work continuing in North Carolina, and there is beginning to be a tendency to try to take up the reclaimed lands that have not definitely been proved to be worth while. We have still left nearly a million acres of swamp land in North Carolina that is of sufficient agricultural value to make the drainage of them profitable, provided a plan is worked out for disposing of the land after it is drained. But there are certain areas that are not of sufficient agricultural value to make it profitable to reclaim the lands, although the engineering problems are easy. There is beginning, and I want to see it checked if possible, a tendency to take up such areas and drain them, with the idea that any land in eastern North Carolina is just as good as any other land and any swamp area can be drained and made a profitable area.

I am now going to revert to the Belgians for just a minute. I believe if we can bring over a certain number of these Belgians as families, have them settle in different parts of our swamp areas and other areas in North Carolina, that they will begin to teach us one thing that will be worth a great deal to us, and that is more intensive and diversified farming. And instead of ever again having North Carolina and other sections of the South so dependent upon one crop that if anything happens to the market of that one crop we will all say we are bankrupt, we will raise other crops as well. Now we speak of cotton as king—"King Cotton." I want to see North Carolina and the other southern states dethrone King Cotton and let diversified farming become king in its stead. If we will do that and the Belgians will help us, we will never again get in the condition that we are in today, where we have made ourselves so dependent on the one-crop system in many sections. You all know that we have raised on plantation after plantation nothing but cotton, and have bought everything else. If we had diversified farming we would not have to be dependent on selling our cotton to get money back into circulation. I want to see King Cotton dethroned and diversified farming take its place.

I wish to thank the Mayor, through Mr. Brett; the Chamber of Commerce, through its President, and the members of the Board of County Commissioners, through Mr. Woodard, Chairman, for the cordial addresses of welcome and the welcome they have extended to us. As Mr. Brett says, it is a little bit cold in here, but if you know the people of Wilson as I do you know that they extend to us a most cordial, a most hospitable and a most warm welcome. While we do not get the warm part in this building, we will get it tonight when we attend the reception and smoker at the rooms of the Commonwealth Club, and I, for one, am very glad to be able to come here to Wilson in connection with the Drainage Convention, because this Association has had strong support from Wilson and vicinity as perhaps from no other section of North Carolina, and the people of Wilson have realized the value of drainage and are ready to spread the gospel of drainage to every section

of the State and help this Association in every way possible to extend this great movement throughout North Carolina, which means so much to the welfare of eastern North Carolina.

In behalf of the Association and in behalf of the delegates attending this Convention I wish to sincerely thank the people of Wilson and all who have taken part in preparing for this Convention and for the welcome they have extended to us.

The following letter from Governor Locke Craig was read by the President of the Association.

EXECUTIVE DEPARTMENT.

RALEIGH, N. C., November 14, 1914.

President North Carolina Drainage Association, Wilson, N. C.:

DEAR SIR:—I regret very much that a previous engagement prevents my attending the Seventh Annual Convention of the North Carolina Drainage Association. I am well acquainted with the drainage work that is being done in the State, and appreciate the value of this work to the development of both the Piedmont and Eastern North Carolina. I can assure you that I am ready to assist in every way I can the work of this association, and the advancement of the drainage and reclamation work in North Carolina.

Very truly,

(Signed) LOCKE CRAIG,
Governor.

Secretary's Report

The President stated that it would be impossible for Mr. Skelding, Secretary of the Association, to attend the Convention, as he was sent by Mr. MacRae, president of the company with which he is associated in Wilmington, on business to Philadelphia. The reports of the proceedings of the last Convention had, however, been printed, and, being accepted by the Convention, were distributed to the delegates present.

Treasurer's Report

The Treasurer's report for the year beginning November, 1913, to November, 1914, was read and referred to an auditing committee, consisting of Mr. P. H. Johnson and Mr. H. M. Lynde.

The appointment of committees was postponed until the President had an opportunity to look over the registration book and make the committees representative of the different sections of the State represented at the Convention.

The first address on the program was to have been given by Hon. William A. Graham, Commissioner of Agriculture, but as he had not reached Wilson, the address was postponed until the afternoon session.

The morning session was then open for any suggestions or business which the delegates might wish to bring up regarding the operation of the North Carolina drainage law or the work in their drainage districts.

Mr. P. H. Johnson, of Beaufort County, spoke in part as follows:

MR. CHAIRMAN:—Just before I left home I was asked by a prominent gentleman in my town, a member of the Board of County Commissioners, if I could tell him who really wrote this drainage law and who had to be responsible for it. I told him that my answer depended somewhat upon what he had to say about it. * * * I told him if he wanted to praise it, why a lot of us had something to do with that law, but if he wanted to condemn it, it would be very hard to find a man who would stand behind it. I have been on both sides of the proposition. I believe I have seen about as much profit and enjoyed about as many benefits from this drainage law as any man in the house. I went further and asked this man why he asked me this question, and he asked me if I thought the people who drafted this law had any idea that any of the land would be sold within ten years after it was drained. Then I saw what he was leading to.

We have rather a peculiar condition. Under our drainage law we file ten books with the sheriff and with the clerk of the court, as you all know, in which the taxes (?) are listed for ten consecutive years, and none of that tax (?) is due within ten years, and, unlike our ordinary tax books that are made for each year, they are made up for ten years. We have no physical sign of the location of the different classes of land in this district. We have five classes. One man may own a tract of land in which some of that land may be in each of those five classes. The law specifically states that the tax shall rest against that land and not against the individual. * * * Suppose a man has a tract of land and sells one hundred acres and keeps four hundred acres. Now the question arises: What class is that hundred acres in that he has sold? The second question is: Who has the authority to change that sheriff's books? After carefully studying this law I have been unable to find out who did, and I will go further to say that I have consulted Mr. Small, who, I believe, has been associated with this Association since its beginning, and other lawyers, and nobody yet has been able to tell me who has the authority to change this tax list. I do not think there are but two, and I am sure there are not over three districts in the State that have begun to collect their taxes yet, and I have come here to have a heart to heart talk with any representatives of these three districts, and I want to know if they have devised any means to settle this difficulty. I will say that we have changed the tax ourselves without authority of law, and trusted the people who own this land to live up to it, and in most instances they have. In some cases they have given us trouble, and were it not for the fact that our money was deposited in the bank at four per cent and we had that interest to draw upon, we would have been swamped. It seems to me that this Convention should consider this point and should adopt some means whereby either the seller or the purchaser of land should immediately list this property with some officer of that particular drainage district, and at the end of each year that officer should file an amended list with the sheriff so that he can go on and collect his tax. That is one question that I think is vital for us to consider.

We have another problem, and every time I attend a drainage convention I expect to bring it up. That is, in the matter of classification. In some districts we may have enough classes, but in our flat land country we have sixteen thousand acres drained by two canals—one nine and the other eleven

miles long. * * * Near the outlet the land is already developed. Most of it is cleared, being cultivated, and up at the head of the canal it was a swamp that was absolutely worthless and only valued at \$50 on the tax books, under water all the time. When these commissioners or viewers started to assess this tax, they began at the mouth and as they went up they raised the tax, and when they got about three miles from there they got to class A and cut two canals through a swamp that would drain a man's land five miles off. * * * That is the condition we have had to face, and I believe that you gentlemen who are now organizing districts and expect to do so in the future can well profit by our experience and ask this Drainage Convention to permit the assessment to go further and extend it to ten classes. It may be that in a great many instances that five are sufficient, where all the land is in the same state of cultivation; but in this flat land country, with patches here and there developed and the rest wilderness, we certainly have not enough classes, and I believe that this Legislative Committee should recommend that change.

The third recommendation that I would make is that I find no authority of law to change our drainage commissioners. They are elected for life, it seems. There is no provision even for a man's resigning, and if he does resign there is no provision for electing another. As Dr. Pratt has well said, we began all right, but it might be time now to make some change. In the matter of payment for the commissioners, the law did not contemplate any payment. I think the last Legislature did that. I have had the displeasure, if I can express it that way, of being chairman of a drainage commission for four or five years, and in the last two years I believe I can safely say that I have done five hundred dollars' worth of work, and I have never had a meeting of the drainage commissioners, and, therefore, would not be entitled to pay. I am not asking for any continuance of this office or pay, but I am stating the facts. In states where everybody has been educated to the operation of this law, why that condition might be logical, but we have to conduct an educational campaign wherever we have a drainage district and that man who has land in that district must be informed in regard to the drainage law and he must be told why his neighbor is in one class and he in another. * * * Aside from that, when you begin to collect your tax, you will find a great many people who are disposed to take advantage of a certain number of technicalities that have outcropped in a district. * * * We may have an exceptional case, but I believe the chairman should be paid a reasonable sum—say fifty dollars a year, and the other commissioners should be paid for their time when they are called to do anything, and let all be paid for their expenses. I have had to go to Norfolk in connection with this, and had to spend some time and money. I am just mentioning my own experience in order that you may understand in case it happens to you. * * *

I do not think I have anything else to propose.

DR. PRATT: I might say in regard to the first suggestion that Mr. Johnson brought up about keeping track of the land as it is sold and the land in different classes: That was taken up very thoroughly at the Raleigh meeting and the Legislative Committee worked on it and it was drafted into a bill. Mr. Johnson brought the same thing up at that meeting, which was

thoroughly discussed, and an amendment was worked out which Mr. Small and a couple of others who were with us considered satisfactory. That was one of the sections of the bill introduced in 1913 that was not passed. * * * Take the case mentioned of the man who had five hundred acres of land. He sold one hundred and kept four hundred. It was a question about the one hundred acres. If that law had been passed in 1913 * * *

The other question in regard to classification: That has been more or less a bone of contention ever since we organized, but how many classes would be necessary in order to equitably divide into districts classes for assessment? That will come up later in connection with the discussion of that proposition. But it is one of those things that needs discussion and needs to be worked out.

In regard to the pay of commissioners: That has not been worked out as satisfactorily as we want it. But you know the General Assembly, when it comes to the question of paying out money or authorizing the paying out of money or making of appropriations, is a hard proposition to run against.

Mr. D. B. McNeill, of Robeson County, had the following suggestions to make:

This is our difficulty: About March, 1912, we organized or finished our drainage district. I think the law says after three years you commence collecting taxes. August the first we sold our bonds and our first installment is due the first of next August, 1915, and we could not think about collecting any tax on it before the following October or November after that. Then if that was only one year we could borrow the money for that length of time, but we would have that to contend with each year after that for the ten years, and then this year the cotton situation has gotten us all down there and we want to know if there can't be recommended by this Association a law enabling drainage districts to sell additional bonds for two years, making it a fifteen-year bond, and the first two bonds we sell to tie down to the last of the list to take care of the first two issued, and that will enable us to collect taxes in the fall of 1916 to be paid in 1917. Two additional years of bonds to refund the first two years are the ones which are due under the thirteen-year plan.

The President of the Association called the attention of the delegates to the exhibits of tile drainage, prepared by Mr. F. R. Baker, Drainage Engineer of the Department of Agriculture of North Carolina. This exhibit was a splendid representation of a farm on which had been installed a system of tile drainage. Attention was also called to the maps and charts of drainage districts completed displayed on the walls; also maps and pictures prepared showing the location of seventy-two districts in North Carolina.

Mr. Brett announced that following the afternoon session an automobile ride and a practical demonstration of laying drain tile by Mr. J. C. Cowley had been arranged for. He also extended on behalf of the citizens of Wilson the privileges of the Commonwealth Club to the delegates in attendance at the Convention.

Upon motion the Convention adjourned to meet at 2:30 o'clock in the City Hall.

AFTERNOON SESSION—Wednesday, November 18

Appointment of Committees

The Convention was called to order by the President, and the following committees appointed:

COMMITTEE ON RESOLUTIONS.

Mr. W. K. Allen, <i>Chairman</i>	New Hanover County.
Hon. John H. Small.....	Beaufort County.
Mr. H. M. Lynde.....	Wake County.
Mr. J. G. Mills.....	Wake County.
Mr. P. H. Johnson.....	Beaufort County.
Mr. S. E. Poe.....	Gaston County.
Mr. J. C. Stanton.....	Wilson County.
Mr. M. E. Sherwin.....	Wake County.
Mr. Charles A. Land.....	Wayne County.
Mr. Zeno Moore.....	Edgecombe County.

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE.

Mr. John A. Wilkinson, <i>Chairman</i>	Beaufort County.
Mr. D. B. McNeill.....	Robeson County.
Mr. R. M. Squires.....	Wake County.
Mr. C. W. Mengel.....	Washington County.
Mr. F. R. Baker.....	Wake County.
Mr. T. W. Chambliss.....	Wilson County.
Major W. W. Peirce.....	Wayne County.
Mr. N. B. Boddie.....	Nash County.

MEMBERSHIP COMMITTEE.

Mr. M. E. Chappel, <i>Chairman</i>	Hyde County.
Mr. E. E. Schooley.....	Beaufort County.
Mr. K. W. Barnes.....	Wilson County.
Miss H. M. Berry.....	Orange County.
Mr. H. D. Brown.....	Wilson County.

LEGISLATIVE COMMITTEE.

Mr. Lawrence Brett, <i>Chairman</i>	Wilson County.
Mr. M. F. H. Gouveneur.....	New Hanover County.
Hon. John H. Small.....	Beaufort County.
Mr. E. B. Crowell.....	
Mr. John P. Kerr.....	Wake County.
Mr. M. W. Thompson.....	Gulford County.
Mr. J. L. Becton.....	New Hanover County.
Mr. J. B. Sellers.....	Robeson County.

The Upbuilding of Eastern Carolina Through Drainage and the Resulting Benefits to the Railroads

MR. B. E. RICE, LAND AND INDUSTRIAL AGENT OF THE NORFOLK SOUTHERN RAILROAD.

Mr. President and Members of the Association:

The public is beginning to realize more each day that a railroad in its operation is similar to a merchandising corporation—they have something to sell and that something is transportation. The railroad is seeking for buyers of transportation the same as the merchant is seeking for buyers of his goods.

The resources of a railroad, its entire income, is based upon the sale of transportation, either passenger or freight.

As the merchant in the city strives to broaden his trade, to increase the number of his customers, to induce people to patronize his store instead of some other, so it is with the railroad. The sale of transportation is limited to the number of customers, and as their buying power is increased or decreased, so is the revenue of the railroad increased or decreased.

The sale of transportation can be decreased through poor service by the railroad or by bad business conditions of the country. If the crops are short there is consequently less tonnage to move, due to no fault on the part of the railroad operation. If the money-worth of the traveling public is reduced, either through poor crops or other causes, the passenger travel of the railroad must be decreased and no inducement on the part of the railroad can improve the percentage of travel to any extent.

The depreciated purchasing power of the public is beyond the control of a railroad and naught that a road can do will add to the sale of transportation, where the decrease is due to lessened crop production.

Any increase in the producing capacity or any improvement in the business conditions of a country traversed by a railroad increases the sale of transportation by that road. Any increase in tonnage increases the earning power of a railroad in still greater proportion, owing to there being more profit in a maximum local haul than in a minimum. The upbuilding of a district by an increased production acreage means enlarged business for the community, and a consequent enlarged business for the railroads serving that community. It not only means more tonnage to be handled outbound in the way of crop movement, but it means an increased exchange cash revenue for the community and a consequent increased earning power for the railroads.

Every additional acre secured to a community and operated at full-crop capacity means that the owner of that acre has additional dollars to spend, and he cannot spend this money without helping the railroad, either directly or indirectly. No matter whether he spends it for passenger travel or in the purchase of food and clothing, it means an increased railroad haul.

If we could only realize the worth of the dollar in its business changes; if we were able to trace that dollar from the time it comes from the soil, from that additional acre of new land; if we could follow that dollar in its wanderings, we would discover that in a comparatively short time it had benefited many people in the community, and had probably traveled on the railroad several times, either as passenger or freight.

We cannot too greatly estimate the value of the new acre that might be

added to a community. It is for this reason that practical drainage is of such vital importance to the railroad and to the state. The welfare of a railroad, its prosperity or its depreciation, is of as much importance to the people as it is to the stockholders of the railroad.

During the last ten years the farmers of North Carolina have been blind to the ways of the politicians. Vicious legislation has been brought about, through the support of the farmer. The misleading politicians have been placing upon the railroads the blame for all the ills of the country. This same vicious legislation, in its effect on the railroads, has reacted in harm to every citizen of the state; every man, woman and child is effected equally with the stockholders of the railroad.

With decreased earning power there must be a forced decrease in railroad operating expenses; a compulsory reduction, regardless of what might be the desire of the railroad management. This reduction in operating costs of a road must result either in the operating of less trains or slower schedules, a reduction in equipment or in the number of employees, or in various other ways, every one of which is to the inconvenience or some form of loss to the traveling and shipping public.

All this has been brought on by the politicians, who in their anxiety for office have used the farmers, the producing people of the state, as stepping stones to political positions. The traveling and shipping public who complain as to decreased railroad accommodations should stop and consider that it is the politician alone who has brought about this change, and they should further realize the fact that no politician ever gets into power except by the votes of the people.

As land is the only possible means for the direct creation of money value, a railroad is directly benefited by every additional productive acre that can be placed in its territory. Each additional acre increases the earning and purchasing power of the township, the county, and the state. It is of still greater worth to the city, to the town, or business center where the dollar from the farm is exchanged for the products of business. This additional created dollar is also of the greatest importance to the railroad, as it not only represents a new outbound crop haul by the railroad, but an inbound haul of a dollar's worth of manufactured products that the farmer must have in exchange for his crop. All this adds to the prosperity of a railroad, and wherever you find a railroad prosperous you will find a smile on the face of the people of the community. The reason is manifest in the fact that the people must likewise be prosperous. They are also in position to enjoy the favor of better railroad accommodations, due to that same prosperity, the additional dollar produced by the added acre of land.

Elbert Hubbard says: "Farming is the primal need, because we get our food out of the soil; next to food is love, and no man is loving, lovely or loveable, who is on half rations." Perhaps Richard Cobden put this more concisely when he said, "The ratio of marriages keeps pace with the price of corn." Only well-fed people are capable of love, and a corn-fed product is always prosperous.

With reference to the value of railroad service, Elbert Hubbard further says, "Next to farming in importance comes transportation, because a thing has to be at a certain place at a certain time in order to possess value. The railroads bridge time and annihilate space." The railroad is therefore the

connecting link, from this new acre, to take the product to where it will be of value. The crop is of no value where it is grown; the bale of cotton, the bushel of corn or the meat-producing animal is of no cash value while it remains on the acre which created it. It must be transported to where it becomes of market value, and the railroad is the essential factor for its moving.

Thus the railroad becomes a partner in the creation of business for a country, but too oft do people fail to give to the road the small meed of praise that is due. Too often does the railroad get censure instead of credit. The public fails to realize that the service possibilities of the railroad must inexorably depend upon the earnings from public patronage. The farmer should also remember that the possibilities of the railroad depend primarily upon the producing power of his farm, the prosperity keeping pace with the increase or decrease of farm acreage.

If the farmer could but realize that his business partner, the railroad, is so seriously affected by vicious legislation then perhaps he would be more consistent in his voting of dangerous politicians into power. If legislators could be made to realize the value and possibilities of good, effective drainage legislation, and could be made to appreciate the dangers and loss from vicious and ignorant railroad legislation, then perhaps they would devote less time to showing railroad officials how to manage a railroad, and with the result that the country and the railroads would be far more prosperous.

With over three million acres of undeveloped farming lands in North Carolina today, awaiting discovery and drainage, there surely is a prime and important need to bring these acres under cultivation. The railroad is vitally interested in the additional acre, but not more so than should be the people of the community, and the state.

The additional acre secured by drainage is an acre worth more than double the acre under long cultivation. This is because the land that needs the drainage has for centuries been accumulating valuable plant deposits and soil worth. Not until proper drainage is effected will this acre ever become available and be converted into a producing factor. Not until it engages in food-making can it aid in love-making and marriages.

The uplands of the state do not show the natural fertility that you find in the bottom lands. As a state North Carolina represents a condition from mountain-top to sea-level. In my talks with people from the western states they often refer to the "poor worn-out lands of North Carolina." My explanation is that they must have visited the higher parts of the state, where ages ago the fertile surface soil was washed into the more low-lying districts. For centuries these lower lands have been undrained and unfit for cultivation. Recent drainage laws of North Carolina are now making these thousands of acres available. The many and rapidly increasing drainage districts of the state are working wonders, and every new acre that is obtained by drainage has a fourfold value, due to its rich producing possibilities.

Thousands of people from the northern and western states are actively and anxiously looking about the South to find certain conditions that will conform to their desires. Seeking a mild climate and low-priced lands they will not be content with the lands that are low in price because of a low producing power. For this low price they must have a rich soil acre. In North Carolina, through drainage, we can create an almost unlimited acreage that while being low in price is capable of the greatest possible production.

As an instance of value of drainage I cite a case from the central part of the state, where a tract of about 50 acres of land, subject to overflow, was reclaimed by canal system. It had never been possible to grow a crop on this land on account of frequent overflow, but as canal construction afforded perfect protection the entire tract was brought into crop production. The owner of this land is authority for the statement that the first year's crop paid the entire cost of canal construction. The real fact was that upon this 50 acres was deposited fertility from more than a hundred acres, all a waste until redeemed and made productive through drainage.

The wonder of today is why drainage was not started in North Carolina a century ago. Had such been the case, instead of there being millions of idle acres in eastern North Carolina today we would have a dense and wealthy population, an area of wonderful producing worth and earning power, a soil value per acre greater than elsewhere in America. The northern and western states are densely populated, and represent an area of high-priced acres. The overflow from the states is seeking a new lodging place and the beckoning hand should point to the wonderful advantages of eastern North Carolina; its rich, wonderful lands, its markets and its mild climate. We have here what the west and the north are seeking, but only through drainage can our lands become available.

A change must be brought about. We must change the condition of the lands; we must change the location of the people. In this change the Norfolk Southern Railroad is greatly interested and stands ready at all times to actively coöperate with organizations and interests that are or may be induced to work along these lines.

Tile Drainage

MR. M. E. SHERWIN, PROFESSOR OF SOILS IN THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

It is a pleasure to me as well as an honor to address this Convention on the subject of "Tile Drainage." Especially is this true in view of the fact, as I understand it, that the North Carolina Drainage Association is now for the first time giving attention in its convention to this subject—a subject which I predict will in the near future claim a major portion of its time.

Tile drainage is a logical conclusion of a drainage district project. It follows the drainage district project just as naturally as harvest follows seed time, and in a certain way it bears the same relation to it; that is, it is the final reward of all the labor and effort that has been previously expended. In addition to paying its own cost, the greatly increased yields obtained justify the enormous expenditures of the laying out and completion of the drainage districts, the chief function of which is the lowering of the water table to allow sufficiently low outlets for the tile drains.

This lowering of the water table, I might say, has in many cases been a real necessity and prerequisite to satisfactory tile drainage. In many cases it has been impossible to get a flow of water from the land till a lower outlet than previously existed was made possible. So that we may say that if tile drainage naturally follows district drainage, then district drainage naturally precedes tile drainage, showing that this Convention in giving its attention first in point of time to that larger, broader and less detailed work and now

coming to tile drainage or drainage of the individual farm and field has not been illogical.

Let us not at this time stop the drainage district work but let us increase the attention given to tile drainage, for in the not very distant future this will be looked upon as the great work of the Drainage Association and of practically all persons interested in drainage. This may not come till near the completion of the larger projects in this State, but it is bound to come.

That underdrainage is more satisfactory than open drainage will be conceded by all because of (1) the cutting of what should be large and easily worked fields into small bodies of land by open drains; (2) the loss of tillable land along the open ditches; and (3) the relative slowness with which water percolates into open drains. These three points have been so generally conceded that I shall not discuss them.

That tile is the most satisfactory of all materials for underdrainage must be conceded when we consider cost, efficiency, and duration of all materials. The cost of any underdrainage may be reduced to two items; first, the cost of labor; and second, the cost of the material that is used. The cost of labor is half the total cost of tile drainage in North Carolina, and is equally great regardless of the material other than tile that may be used. So there can be no saving on labor, no saving on that half of the cost of drainage by the use of other material than tile. In some cases the labor of ditching is greater for the other materials than tile because these materials require larger, wider ditches, making the handling of more dirt necessary. Certainly no saving can be made in the item of labor; let us consider whether any saving can be made in the other item of cost by the selection of materials other than tile.

Among materials to be considered are plank, poles, rock, and brush. At market prices the lumber for small plank drains will run a little lower than the cost of tile, but for the larger drains a little higher than for the cost of tile. As an average, we will find no saving in first cost. And when we consider the life of the two materials we have to throw the plank out of consideration at once as plank put in a soil which is subject to considerable variation in moisture content has a very short life. In a soil which remains waterlogged, plank drains will last a long time, but we must consider that a field which remains waterlogged is improperly drained and hence that plank is not the material to use in economical and efficient drainage.

Poles have been used and are sometimes cheaper than plank, but their low efficiency in the carrying of water and their short length of life make them very expensive drains in the end.

Rock is another material sometimes used. The cost of installing this is certainly greater than the cost of installing tile. Where it is used the rock is abundant and costs nothing but the hauling, but this cost is tremendous, as any of you that have ever tried rock hauling know. The only conditions under which rock can be used profitably are that the rock must be gotten rid of for other reasons and that there is no waste land on which to pile them. Under these conditions they can sometimes be profitably buried underground, but they serve generally as poor water channels in comparison with tile.

Brush has sometimes been used as a material for underdrainage. It is very inefficient as a carrier of water and its life being so very short it cannot be considered as a material for permanent drainage.

So, after considering the cost, the efficiency and the length of life of all these materials that may be used for underdrainage, tile must be recognized as supreme; and if we look at the experience of other states we would decide that our conclusion is correct, for all the states that have done any great amount of underdrainage have used for years past practically nothing but tile. They have abandoned the plank, the pole, the rock, and the brush, and are using very large amounts of tile. I wish we could say that North Carolina has put in a large amount. The time will come when we can say that.

At this time I want to consider briefly the benefits of thorough drainage. I shall not go into this subject very extensively. I have a few diagrams here that I want to show and the following list of the major benefits of drainage.

1. Improves the granulation of clay soils.
2. Increases the water-holding capacity.
3. Improves the aeration of the soil.
4. Deepens the rooting of crops.
5. Promotes the growth of desirable bacteria.
6. Reduces the erosion of sloping lands.

Let us consider these benefits one at a time.

It improves the granulation of clay. If we examine a clay soil and rub between the fingers what we might assume to be one particle of clay, it will spread out to ten thousand tiny particles or single clay grains, any one of which is too small to be seen with the naked eye. A soil in good tilth has these clay grains arranged in groups which we term granules or crumbs. You can see by the accompanying diagrams, page 27, that if we have the single grains massed together as in Fig. 2 the spaces intervening between the grains must be very small. If we get those grains grouped as in Fig. 1 we will have the same sized spaces within the granules (compare Fig. 1 and Fig. 2) and will have additional larger spaces between the groups of grains (Fig. 1). These spaces between the groups of grains compare in size very favorably with the spaces between sand grains in a sandy soil, so that such a granulated clay in its moisture and air relations has the desirable qualities of a sandy soil but without the undesirable qualities that some sands possess.

It increases the waterholding capacity. The water in any soil is held on the surface of the soil grains and in the open spaces between grains and between granules. It is not absorbed into the mineral substances of the soil. In an ungranulated clay soil, as can be seen from the diagram, Fig. 2, page 27, the grains are so massed together that there is not much space for water without almost total exclusion of the air. That tile drainage increases the amount of available or capillary moisture is shown by the following table, the result of an experiment by the late F. H. King, of Wisconsin, formerly chief of the Division of Soil Management, U. S. Department of Agriculture.

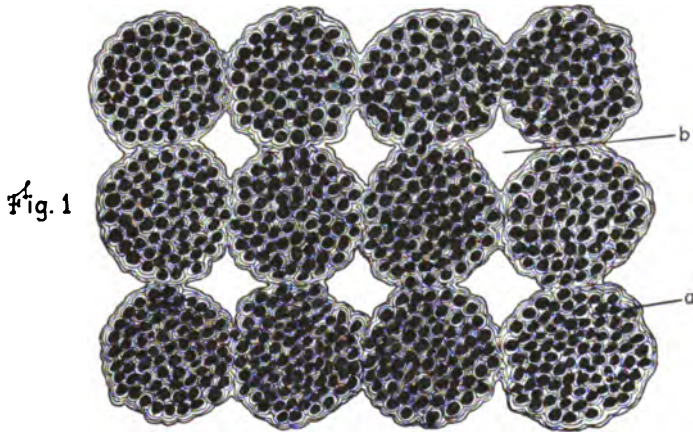
	<i>Capillary water absorbed by 36 inches of soil.</i>
Drained	7.50 inches
Not drained	6.66 inches
Difference .....	.84 inches

In this experiment in which both soils were dried before testing them in respect to absorption of water the previously drained soil was shown to

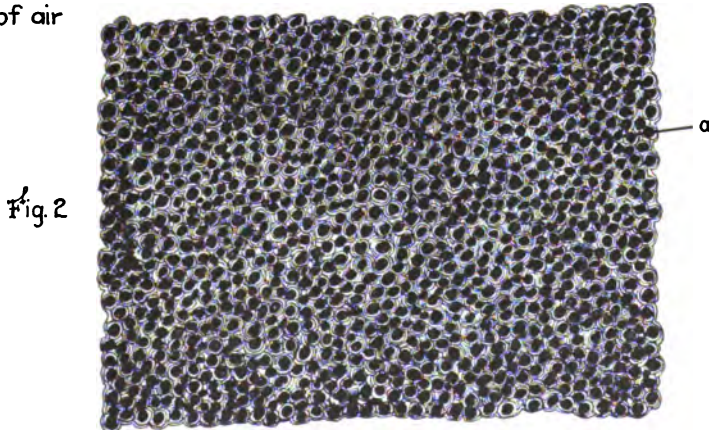
absorb more than four-fifths of an inch of rain in excess of that absorbed by the previously undrained soil. This is equal to nearly two hundred thousand pounds of water per acre.

It improves the aeration of the soil. The drained soil which has become

Ideal grouping of soil grains induced by proper drainage.
Note the abundance of pore space for both water and air.

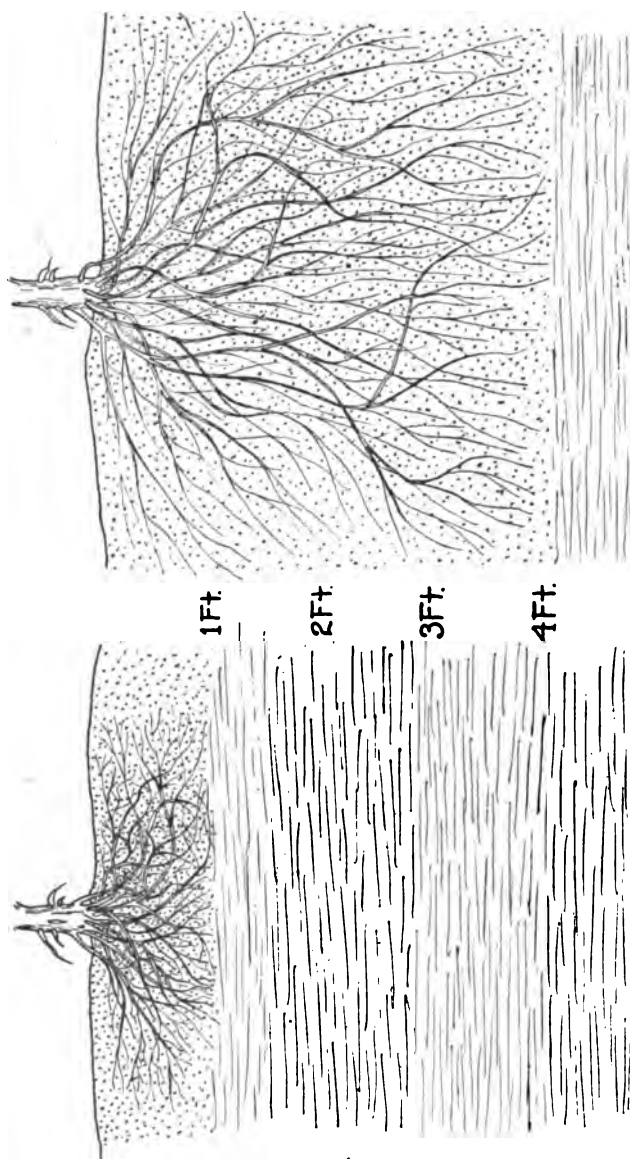


Massing of soil grains in soil puddled by lack of drainage
Note the small amount of pore space for water and the absence of air



well granulated, in addition to having an increased storage capacity for water, has considerable space left for the movement of air (see b, Fig. 1). This air space does not appear in wet, undrained soils though air is just as necessary to the growth of ordinary farm crops as water or plant food, or any other natural substance. The roots of plants can not live without air. The killing of plants by drowning, as we say, is not due to the ill effects of

Fig. 3.
Shallow rooting with poor drainage. Deep rooting with water table lowered.



water, but to the lack of air. A man under water does not drown because the water gets into his lungs, but because the air is excluded.

We must have not only air, but fairly free movement of air, in the soil. An underdrain when not full of water furnishes an inlet and outlet for air deep in the soil, thus helping to establish free movement of air through the soil. This effect, that of supplying air through the drain and in aiding of the circulation of air in the soil has been recognized by truckers and others who have drained their soils as one of the real benefits.

It deepens the rooting of crops. If the water table is lowered by drainage from one foot to four feet, as shown in Fig. 3, page 28, the feeding area of the crop is quadrupled. On undrained land crops which are forced to root close to the surface early in the season and early in their growing period are not able to follow the moisture line downward when dry weather comes later in the season. Hence they may suffer for water though water is only a few feet below the surface. But in land thoroughly drained the crop roots go deeply while the crop is still young and able to extend its roots, and so the crop is not seriously affected by dry weather. Many soils which to the casual observer and even to the farmer do not seem in great need of drainage may nevertheless be greatly helped by it.

It promotes the growth of desirable bacteria. The "life of the soil" is made up largely of real living organisms, the bacteria and fungi. Give us a soil without bacterial action in it and we have a soil which is usually far from fertile. In a soil which is waterlogged the beneficial bacteria are unable to thrive; the bacteria which are present being usually injurious rather than beneficial. It seems that most of the helpful bacteria must have air; and to get air so that these bacteria can work is important.

It reduces the erosion of sloping land. There is vastly more loss of plant food by erosion than in all the crops that are taken from the land. Drainage prevents erosion by allowing the water to enter the soil. In a field where the soil is comparatively dry, there is considerable air present in the soil. When rain falls it wets the whole surface of the soil at once, blocking the way for the escape of the air. But the air must pass out before the water can get in, so the air is forced to bubble out through the water surface or be forced out below. In any land which has no under-drain the nearest exit below is the other side of the world, so that naturally it bubbles up through the surface water and by so doing impedes the passage of water into the soil. Our experiments at the College indicate that in our clay soils water will soak into under-drained soil 40 per cent faster than into the same soil not under-drained. This increase is due to the fact that the under-drain furnishes an opening connected with an outlet through which the air can escape; so that when rain water enters the soil it presses the air out through the drain ahead of the water. This allows, as I said, about 40 per cent more water to enter the soil and that much less to flow off over the surface. This means much in the saving of our fields from erosion.

There is just one more point I wish to make, and that is in regard to the cost of tile drainage. This will vary, of course, with the spacing of the drains. On the heavy clay soils we have to space the drains rather closely while the sandy soils will be thoroughly drained with a wider spacing. Also certain crops need a closer spacing of drains than others, because they require a quicker withdrawal of water from the land. In general it is the crops with

a high value per acre, like truck crops, that require and pay for a closer spacing of drains. So we find truckers spacing drains from 15 to 60 feet apart, while the general farmer spaces his drains from 40 to 50 to 100 or 150 feet apart.

The cost will, of course, vary with the spacing, but we may consider the average cost in North Carolina at twenty-five dollars an acre. And we should always consider this as an investment; never as an expense. It is an investment because it pays interest on the money expended. A net income of ten per cent a year would be considered a very good interest rate, and to net this at the above cost of draining the increased value of the crop would have to be only \$2.50 per acre a year. It takes no more work to plant, cultivate and harvest a crop on tile drained land than on land not drained, so that whatever the increase is, it can be considered interest on the investment. To net ten per cent, then, would require an increase of only about two and a half bushels of corn at North Carolina prices. On this basis most of our land would pay twenty-five, fifty or one hundred per cent a year for drainage. There are thousands, probably millions, of acres in the State that would pay these rates of interest for money invested in tile drainage.

The afternoon session was closed with address of Mr. H. M. Lynde, Drainage Engineer of the United States office of Drainage Investigations, who spoke on "Importance and Principles of Farm Drainage."

The Importance and Principles of Farm Drainage

BY H. M. LYNDE, DRAINAGE ENGINEER, UNITED STATES DEPARTMENT OF AGRICULTURE.

Mr. President and Gentlemen of the North Carolina Drainage Association:

I thank you for the opportunity of speaking on the "Importance and Principles of Farm Drainage." Not enough has been said on this important subject—important because it strikes home to each individual farmer who has to ditch his land to get rid of the excess water. It is admitted that drainage lies at the basis of successful agriculture in the Coastal Plain Region, which comprises an area of over 14,000,000 acres, nearly one-half the total area of the State. Everywhere one goes in this section the needs of drainage are evidenced by the large number of open ditches on nearly every farm. Most of the land is gently rolling or flat, with a clay subsoil and the underdrainage is usually poor. The average annual rainfall varies from 45 to 60 inches and many of the storms occurring are intense at the time. In the Piedmont and Mountain regions of the state, every farm has its shallow ditch through hollows or depressions to drain these places, so that the subject of farm drainage is statewide in its importance. It has been estimated that from five to six million acres of land now under cultivation is in need of better drainage in one way or another. The most important type of drainage in North Carolina today is the drainage of the large area of poorly drained farms, for is it not true that the ultimate end of all drainage improvements is the improvement of the individual farm?

True, the speaker admits that all efforts to drain individual farms without first having an adequate outlet, either one provided by nature or one constructed by man, will be useless, but thanks to the working of a good state

drainage law and the progressiveness and enthusiasm of the residents of the state, these larger drainage problems are being solved at a rapid rate and it is only a matter of time before the entire state will be provided with outlet drainage. It may be said that it has become a popular movement and probably no other state in the South is as far ahead in the development of its swamps and overflowed lands as North Carolina. But the drainage of these large areas is already keeping pace with the demand for land and so why not pay more attention to some of the lands now under cultivation and make Farm Drainage as popular as it is in the Middle West, where the soil is no better and the climate not as good as in North Carolina? Why should the farmers in the eastern part of the state take it as a matter of course to be "drowned out" about once in every four years? Already in that territory organized drainage districts have begun the preliminary work of drainage and the large open canal is frequent. But more complete drainage than this is necessary to drain the individual farm. The object of this paper is to present in as clear and concise a manner as possible the general need, together with the underlying principles of, and the many benefits to be derived from, better, shall we call it, soil drainage, which is a matter not confined to swamps or the mere removal of surface water. "The basis of good soil management is a correct water supply, not too much nor too little, but the right amount at the right time."

RECOGNIZING THE NEED OF DRAINAGE.

What lands need drainage and what are the evidences of lack of drainage or of poor drainage? As a general rule, the presence of standing water in natural depressions, in furrows, and along roadsides or for longer than a day or so at a time anywhere on farm lands is an indication of imperfect drainage. The appearance of water on the surface during the rainy season means that the water has risen from below to that position. In other words, the ground is completely saturated with water. The dwarfed appearance of crops on cultivated fields after the winter rains are over also is an evidence of lack of drainage. When it is impossible to tell by surface indications the character of drainage, the depth of the water table may be ascertained by using a hand auger. If the ground water level is found to stand too close to the surface, say one, two, or even three feet for weeks at a time, or in other words, at a point higher than that which crops would eventually extend their root system in search of food, the water will as a general thing, interfere with crop production. The nearer the surface, the poorer the drainage, under ordinary circumstances.

In providing artificial drainage for land, the problem is one largely of removing a sufficiently large proportion of the excess water that accumulates during the most rainy periods, so that the soils or crops may not suffer injury. A properly designed drainage system should provide for so rapid a removal of the water that at no point will it stand upon growing crops for much over a day. It is safe to say that all land wherein the water table is within three feet of the surface of the soil for any great length of time during the growing season, can be materially benefited. Here in the Coastal Plain Region, the annual rainfall is heavy and the storms are often intense at the time and the capacity of the soil is overtaxed, and as a consequence water fills the ground for long periods of time or stands upon the surface.

The slopes of the land, the quickness of the rainfall and its intensity are the factors that determine the ability of a region to drain itself of surface water.

WATER IN SOILS.

There are two essential kinds of water in soils, namely: 1. Hydrostatic or gravitational water; 2. Capillary water.

Gravitational Water is the water in soils that obeys the laws of gravity by moving downward through the soil. It usually comes from an external source, like surface water, springs, etc. For the proper growth of plant life the presence of air in the soil is as essential as the presence of water. There should be a proper balance of air and water in the soil spaces. Hence, it is apparent that too long occupation of the air cells by water will do harm. This occurs when there is no ready way for the escape of the water.

The water that is used and all that is needed for plant growth is known as *Capillary Water*. In well drained soils this is the water which is retained in thin films on the soil particles after the hydrostatic water has disappeared from near the surface of the ground. It is moved only by capillary attraction and is not under the laws of gravity. Its supply is replenished from the hydrostatic water. Drainage does not remove any water which would be beneficial if it remained. It simply removes the static water. It has been stated by an authority that "of the from 30 to 60 per cent of moisture which soils can hold, it is possible to remove only one-half by drainage. The loss of this quantity leaves open air spaces in the soil, although it still contains 15 to 30 per cent of its own volume of water. Plant growth requires as much moisture as this in the soil; more than this is too much, less is too little."

Some soils with a sandy or sandy-loam subsoil possess natural drainage properties so that the hydrostatic water level, or water table, is lowered a sufficient depth below the surface in a short time, so that no harm is done to the plant. Other soils, especially on land of a flat nature, with a clay subsoil, retain the water at or close to the surface for days or weeks at a time, and some means of artificial drainage must be employed. This is practically the condition prevailing over much of the Coastal Plain Region, and, also, on some rolling land near the "fall line."

Any sort of channel that rids the soil of surplus water by carrying it down through the soil first is effective. The two methods which may be employed are the open ditch and the under drain.

THE OPEN DITCH.

The open ditch has its place in all drainage work, and one of its main values is to furnish outlets for tile drains. As a means of lateral drainage, they are not the most efficient, however. In sandy ground they are probably as efficient as tile drains, but in heavy clay, or loam soils they afford only imperfect drainage, due to the slow percolation of the water through the soil and to the fact that the sides of a clay ditch become more or less puddled, which tends to seal the exposed soil spaces and impede the passage of water into the ditch. When this happens a large portion of the water flows over the surface into the ditch, rather than down through the soil, and then off. This is not a desirable condition, because the water is given no opportunity to replenish the supply of moisture. It also tends to produce surface wash and consequent loss of fertility.

For agricultural purposes the common surface ditches are of low efficiency, and expensive. They are often not deep enough and so do not remove the water from a sufficient depth of soil nor for a very great distance on either side, especially in clay soils; their grade is usually poor and the water flows slowly or not at all. The ditch obstructs the surface, cutting the farm up into irregular-shaped fields, interferes with tillage and harbors weeds. The space they occupy amounts to about 4 per cent of the area on many farms, which on valuable land is too much space to be lying idle. They interfere with the use of modern machinery and the time lost in turning the teams is a great factor to be considered. Such ditches must be renewed from year to year, all of which makes them more expensive over a long period of years than underdrains. Another objection to open ditches is the fact that they are usually not spaced close enough together to give thorough drainage, for if they were, they would be more of a nuisance than they now are.

UNDERDRAINS.

Poles, plank, brush, and stone have been used for underdrains and have given good service while they lasted. But usually the length of time that they will give good service is short, caused either by the decaying of the wood or the accumulation of silt. The best material for underdrains and the one being used more and more as people recognize its value, is tile.

In an underdrained field there is a more continuous and free flow of water than in an open ditch. All the water passes down through the soil, thus replenishing the moisture in the soil, instead of passing off over the surface, as oftentimes happens in fields drained by open ditches.

There is always to be found in the lower portions of the soil or subsoil, water filling all the spaces commonly called ground water, held there by some impervious strata. The top line of this water is spoken of as the water table. Its distance below the surface depends mainly upon the efficiency of the underdrainage, either natural or artificial. During a heavy rainfall the water table is high, often at the surface of the ground. Gravity, drawing the water down as rapidly as it can find an outlet, gradually lowers the water table. A line of tile laid in the ground provides an open channel. The particles of water nearest the drain having a shorter distance to go, find their way first into the tile, followed by others next to them. The water table between the lines of tile is gradually lowered by the water seeking an outlet into the tile lines, by passing downward and laterally to the open channel, the water table forming a convex curve. During a long dry spell this curve becomes flatter and flatter.

EFFECTS OF DRAINAGE UPON THE SOIL.*

"The first effect of the removal of surplus water from the soil is *aeration*, or the admission of air into the spaces previously filled with water.

"As a result of the aeration of the entire body of the soil, a *greater depth of soil* is the first result seen. While the soil, technically speaking, extends to the subsoil, yet only that in which air circulates can be used by plants.

"Next, by this increase in the depth of soil an *extended range of roots* is at once made possible. Experiments have shown that the roots of grains and

*From Elliott's "Practical Farm Drainage."

grasses, and often vegetables, will in favorable soils extend their roots to a depth of three or four feet, or even deeper. The roots also push themselves laterally to a greater extent in an aerated soil, all of which contribute to a vigorous growth of the plant.

"The drainage of the soil *improves the granulation and texture* of the soil. The structure is changed so that it becomes more pliable and easy of culture. Owing to the breaking up and enlarging of the capillary tubes it retains its moisture better.

"Another beneficial effect of drainage upon the soil is an *increase in temperature*. Water is very much more difficult to heat than the solid matter of the soil. Authorities state that it requires about ten times the amount of heat to raise a given volume of water to a desired temperature as is necessary to raise an equal volume of soil particles to the same temperature. Hence the less water in the soil the more quickly it is warmed. A difference in temperature of from 6 to 10 degrees in undrained and drained soil is often noted.

"Drainage promotes the *growth of desirable organisms*. Soil investigators have demonstrated that an abundance of air, a proper amount of moisture, and a temperature between 70 degrees F. and 105 degrees F. are the environment most congenial to the growth of the desirable organisms. As we have just seen, these are the conditions of soil brought about by drainage."

PRACTICAL BENEFITS OF DRAINAGE.

The practical benefits resulting from the improved condition of the soil just stated may be enumerated as follows, as stated by Elliott in his "Practical Farm Drainage":

1. *Land is ready for seeding earlier.* As the ground thaws, the water is at once carried down to the drains. The result is that the soil is dried out more quickly, with a corresponding increase in temperature and the land is found to be ready for cultivation from one to three weeks earlier than undrained land.

2. *Crops begin a healthy growth at once* and maintain a much more vigorous growth throughout in a drained than in an undrained soil. This is due to the fact that all the conditions for plant growth are most favorable; the right amount of air, moisture, and heat, extended root range, availability of fertile elements, increased activity of beneficial bacteria.

3. *Fertilizers are not wasted by surface washing.* The fertilizers are carried directly into the soil instead of passing off over the surface.

4. *Crops are better able to withstand drought.* The greater depth of soil and the extended range of roots, together with the change in the texture of the soil rendering it capable of retaining more moisture, are among the causes which enable a crop to pass through a period of drought safely.

5. *There is no loss of crops from heavy rains.* A sufficient number of drains of proper size, accurately laid, will carry off the heaviest rainfall so rapidly as to prevent any serious injury to the crop.

6. *Frost does less injury to crops.* This applies both to late spring or early fall frosts.

7. *The profits from the land are greatly increased.* It makes hitherto waste lands highly productive. It doubles and sometimes triples the yield per acre. It lessens the expense of cultivation because young crops are no longer

drowned out, necessitating replanting and there is no waste of time and labor in cultivating irregular fields.

8. *Sanitary conditions of the farm are improved* because the removal of water by drainage lessens the danger of malaria.

9. *The attractiveness of farm premises is increased.*

10. *Disease among farm animals is decreased.*

TILE DRAINAGE.

The ideal form of drainage, in order to obtain all the benefits enumerated, is underdrainage, and the ideal form of underdrainage is tile drainage.

"Tile drainage consists of tiles laid at proper depths and intervals, of sizes sufficient to carry away all water coming to them before the soil would be injured by saturation." Tile may be made of burned clay or concrete.

CLAY TILE.

Clay tile may be either soft or hard, burned or vitrified. The hard burned or vitrified tile are the most durable because they are stronger and the walls are less porous, thus being better protected against frost action. The drainage efficiency of tile is not affected by the difference in porosity of the walls. The walls of a porous tile will absorb water quickly until saturated, but, beyond that, no appreciable amount of water goes through the walls. The conclusion has been reached by experiment that the porous property in tile has no value for draining. *The water enters the tile through the joints.*

CONCRETE TILE.

Concrete tile has come into use in more recent years and is extensively used in the middle west. If properly made it is probably as good as clay tile. On account of the newness of concrete tile for drainage we do not have the basis of long continued use to determine their adaptability, as we do in the case of clay tile. Failures have occurred, but so also have they in the clay tile. Some of the arguments made in favor of concrete tile are: That it is more smooth and uniform in shape than clay tile, and that because of its porosity water will pass through the wall of the tile and hence drain the land more thoroughly, but as has just been stated, the results of experiments with porous clay tile show that the porosity of tile is of no value in underdrainage.

With concrete tile, what failures have occurred have been due to aggregates of poor quality, poor or ignorant workmanship or improper treatment in the process of manufacture. The leading manufacturers of cement recommend that tile be made of a rich mixture and be as non-porous as possible. A porous concrete tile, as a general rule, is evidence of weakness. It is difficult to make satisfactory concrete tile on the farm because of the lack of adequate facilities. The best place for them to be made is in a factory, where all the facilities for proper mixing, molding and curing of them are at hand. Special care should be used in curing the tile, as a well made tile may be ruined by improper curing. Particular attention is called to the fact that a good quality of sand should be used, a fact which is often overlooked by the average farmer. Sand for concrete tile should be both fine and coarse up to one-fourth inch in diameter, and it should also be clean and sharp. The average fine, water-torn sand of the Coastal Plain Region, is not suitable for concrete tile, in the writer's opinion. Compared with clay tile, its cost if properly made at a factory, has not been much lower than clay tile in North Carolina.

ARRANGEMENT OF DRAINS.

The arrangement of drains is determined largely by the topography of the land, although for level land there are several recognized systems which are more or less closely followed by drainage engineers. In general, the main should take the same general location and direction which the water takes, in the wet time, to get off the land. Laterals should be made in straight lines so far as possible, and straight down the slope. On comparatively flat land the laterals should generally be arranged in more or less parallel lines at such intervals as will accommodate the soil. Short mains with long laterals is one of the most economical arrangements, if it can be secured. Every main and submain drains the land a certain distance each side of it, and the laterals passing through this portion are of no service to the land; in other words the land adjacent to the mains is double-drained. If possible, have the laterals discharge into the mains on one side only. Make one main serve as many laterals as possible, so as to avoid an unnecessary number of outlets, which always require more or less attention.

While all the above arrangement of drains cannot be followed in most cases, and will have to be modified more or less by local conditions, yet it is well for the farmer to keep them in mind, if he wishes to secure the most drainage for the least cost. Above all things, do not install your tile haphazardly, but plan your whole system first, and then install such portions as you see fit, adding to it later on, so that they will ultimately form links of a completed system. If this is not done, much of the money first expended may thereby be thrown away.

THE DEPTH AND DISTANCE APART OF DRAINS.

The depth and distance apart of drains will be largely determined by the texture of the soil. With regard to depth of drainage, Elliott states that 4 to 4½ feet is called deep, 3 feet medium, and 2 to 2½ feet shallow. The proper distance apart of drains is a subject that is closely related to their depth. We have spoken of how the ground water level is lowered between the lines of tile, in a curved line, the highest point being midway between the drains and the lowest point directly above them. The distance apart and depth of tile should be such as to reduce the ground water level between the drains to a point most beneficial to plant growth, within about 24 hours after the ground has been saturated.

In sandy land the drains may be placed deeper than in clay land, and with an increase in depth spaced wider apart. In clay land an increase in the depth of tile will usually not permit an increase in the interval between drains, because of the sluggishness of soil water movement in clay soils, which will cause the water table to be lowered too slowly to be of benefit to the crops.

In North Carolina, except in the stiffer soils, like pipe clay, etc., for general field crops, an average depth of 3 feet for laterals will usually give good results. A spacing closer than 60 feet makes tile drainage so costly that it is not recommended, except on valuable land. A spacing of 100 feet is giving good results in portions of the Coastal Plain Region.

As a basis for the proper distance apart of drains, Elliott states for the different types of soils—in close, dense soils, 30 to 40 feet; in clay, loam and sandy clay, 60 feet; in sandy loam soils, 100 feet; in gravelly soils, 150 to 200

feet. For trucking crops a closer spacing is necessary than for general field crops.

GRADE.

A very small grade will suffice for the flow of water in tile. Tile drains will operate on a grade of a half inch per 100 feet, but a fall of 6 inches or more per 100 feet is much more desirable. The less the fall the greater the precautions that must be taken in the construction work and relatively larger tile must be used.

SIZE OF TILE.

The size of tile will be determined largely by the area drained, the grade, the texture of the soil, and the amount and intensity of the rainfall.

The size of the tile increases with the area drained by that tile, thus drains spaced far apart need to be larger than drains placed close together.

The size of the tile decreases as the grade increases, since the quantity of water a tile can carry is the product of the cross-sectional area of the tile and the velocity of the water. The velocity of the water is greater with a steep grade than with a flat grade. Hence if the grade is decreased the cross-sectional area must be increased.

In general terms, tile drains need to be larger in a soil of open texture than in a dense soil, since the water passes through the soil to the drains faster and the tile must be capable of carrying off this water. For ordinary crops the size of the tile should be such that they will be capable of removing surplus water from the surface of the ground within thirty-six hours, or better, within twenty-four hours. In regions of intense and large rainfall, taking into consideration the climate and season of the year in which they occur, of course, and where unusual storms may be expected, the size of the tile should be larger than in regions where the rainfall is small or normal and not subject to heavy downpours.

Where the annual rainfall is thirty-five to forty-five inches and under standard conditions of climate, surface and soil, it has been found that satisfactory drainage can be obtained if the mains are designed large enough to remove one-quarter inch in depth of water from the area drained in twenty-four hours. In some sections of North Carolina, the annual rainfall amounts to from forty-five to sixty inches, but the climate offsets to a large extent the damaging effect of this large rainfall, and what systems we have installed have been designed to remove a runoff of one-quarter inch in depth of water in twenty-four hours and appear to be giving good drainage. According to the records of the Weather Bureau, July and August are usually the wettest months of the year, and yet it is those very months in which droughts occur. Evidently the plants and evaporation play quite a part in taking up a considerable portion of the water. If this be the case, then it seems proper to use the one-quarter inch runoff until further investigations warrant a change.

No attempt should be made to make the capacity of the mains equal to the combined capacity of the laterals. Tile less than four inches in diameter are not recommended, especially where the grades are low and the soil more or less sandy, this because of the danger of the smaller sizes becoming clogged with silt.

CONSTRUCTION OF TILE DRAINS.

Unless the area is large, a series of surface elevations along the lines where the drains are to be laid will be sufficient to determine the grade of the drain.

The first important requirement for the successful making of a tile drainage system is to have a good outlet. A free outlet should be obtained whenever possible; that is, the water from the tile should discharge above the water level in the outlet ditch or stream. At the outlet a headwall of stone, brick or concrete should be made, so that the outlet pipe will be held in place and the bank protected from caving. The lower ends of the mains for a distance of ten feet from the outlet should be constructed of sewer pipe or iron pipe and the joints should be cemented. The end of the drain should also be protected by wire screening to prevent the entrance of small animals or trash.

The ditches are usually laid out by pairs of stakes, one a guide from two to three feet long and about four inches wide, on which the station number and depth to dig are given, and one a small square stake driven flush with the ground upon which levels are taken, and from which all measurements are taken. The ditch is dug at a distance of about ten inches to one side of the line of stakes. A narrow ditch is the most economical because less material needs to be removed, and a width of twelve inches on top will be wide enough for a ditch three feet deep. After the ditch is partly dug, place the grading line in position, setting it a convenient height above the surface, and at a constant distance above the bottom of the proposed grade line. Then by the use of the grade stick of the required length, which length is the distance below the line to the bottom of the ditch, the bottom may be graded. It is very important that the bottom of the ditch be made smooth and uniform with no sags in the line.

Small systems are usually dug by hand, and the tools necessary for this, outside the regular shovels, are the ditching spade and the tile scoop for preparing the bottom. Start the ditch at the outlet and work up grade.

The tile may either be laid by hand or by a tile hook, if small sizes are used. Begin at the outlet and work up grade. If the ends are not square, let any opening come at the bottom and cause the tops to join closely. Openings of one-quarter inch or more should be covered with broken pieces of tile or a dab of cement. Curves may be made by either chipping one side of the tile or by covering the openings with cement or broken pieces of tile. In making junctions use the "Y" joints, which are special pieces made by manufacturers. Drains should join at an acute rather than a right angle.

As soon as the tile are laid they should be fixed in place by blinding, which consists in placing moist earth from the sides of the ditch at the sides and top of the tile, for a depth of about six inches. The ditch can then be filled in by shovels or by using team and scraper.

COST OF TILE DRAINAGE.

The cost of tile drainage varies greatly, depending on the nature of the soil, presence of stone and roots, the spacing, the depth, size of tile, season when done, method of construction, and the local labor conditions. For six-inch tile or under, in this section, the cost of digging the ditch, laying the tile, and blinding and refilling ought not to exceed nine cents per linear yard

for a ditch three feet deep. The cost of tile ranges from twenty dollars per thousand feet for four inch to forty dollars per thousand feet for the six-inch in car lots, f. o. b. at the factory. With freight added, these prices will ordinarily be twenty-five and forty-five dollars respectively. For sizes larger than six-inch the tile manufacturers in this section usually sell No. 2 sewer pipe, eight-inch costs seven to eight and one-half cents per foot, ten-inch, eleven and one-half to thirteen cents per foot, twelve-inch, fifteen to seventeen and one-half cents per foot.

With the above prices and assuming an acre of land to be drained with four-inch tile, the cost will range from sixteen dollars for tile spaced one hundred and fifty feet apart to forty dollars for tile spaced sixty feet apart. To this cost must be added the cost of larger mains, hauling of tile from depot to the farm, and cost of accessories like silt-wells and headwalls. Also, add to this the cost of the engineering, which is variable.

Hence it is evident that the drainage of farm lands is not an inexpensive operation. The exact knowledge of this cost does not mean much to the farmer, unless at the same time a fairly accurate idea of the profit to be expected from drainage can be given him. It might be well to state here that all land does not need systematic, regular systems in which case the average cost per acre may be reduced to \$10 or \$15.

The extent to which tile drainage has been practiced in North Carolina is not such as to bring before its inhabitants in general the far-reaching importance of it. Considerable tile has been laid in the draining of ponds, swales and springs, but not very much systematic drainage has been done. For this reason, we must draw, to a large extent, from the experience and records of both cost and benefits in Iowa, Illinois and other States in the Middle West. Fifteen years ago, there was probably no more interest in underdrainage in that section than there is in North Carolina at the present time. There seems to be no doubt but that the installation of tile in the South pays just as large or larger returns than in the Middle West, and as the population becomes greater, underdrainage is going to be more extensively practiced. As the country becomes more densely settled, there is going to be an increased demand for land, and as the price increases it will become more and more profitable to drain our wet farms.

There is an impression that our Southern lands are too low in price to pay us for this expensive work of tile drainage, but with the high prices that all farm products command today and the numerous markets within reach of the farmer, it seems that it would pay to underdrain all land where there is the least chance for a failure or partial failure. This would apply especially to truck crops. Why not put our lands in such a shape that they can be depended upon to produce "bumper" crops each year? Underdraining our "cheap" lands will be one of the means of getting rid of their cheapness and they will become valuable.

One of the reasons why tile drainage is not practiced more here in North Carolina is that the great results of underdrainage are not generally understood. Another is that the critical operations of putting in a tile system are even less understood than its benefits, and farmers believing that it is more difficult than it really is, fearing to make a mistake, leave it alone.

The average farmer feels that he can not afford to drain as the cost is too great. Dr. W. I. Chamberlain in his little book on tile drainage answers the

question, "When can we afford to drain?" in this manner, "*We can not afford not to drain if we have land that we need for tillage and rotation, and which is naturally unfit for it, but which can be fitted for it by tile drainage. Shall we wait till we are out of debt and have money to tile it, or shall we tile it in order to get out of debt? The latter as a rule.*"

Tile drains, properly installed, are a permanent investment, and very little maintenance is required. The increase of from six to ten years crops will usually pay for the cost of drainage, after which the increase in the crops caused by drainage is an annual profit for an indefinite time. Underdrainage is becoming more popular in North Carolina and from present indications the writer looks to see the most extensive work of this character that is done in the United States during the next ten years carried on in this and other Southern States.

At the close of the afternoon session the delegates were carried in automobiles to see a practical demonstration of tile drainage by Mr. J. C. Cowley.

At eight o'clock in the evening an informal reception and smoker was given the delegates by the citizens of Wilson at the Commonwealth Club.

MORNING SESSION—Thursday, November 19

At nine o'clock the delegates assembled at the Briggs Hotel and went to a tobacco warehouse where they witnessed a tobacco sale.

The morning session was opened with prayer by Reverend A. W. Cheatham, Rector, St. Timothy Episcopal Church.

The President read the following telegram from Mr. M. V. Richards, Land and Industrial Agent of the Southern Railway, who had been expected to make an address to the Convention.

Am very sorry it will not be possible for me to attend meeting of your Association tomorrow, November 18. Must go to Southern Georgia. Greatly interested in your aims. Best wishes for splendid convention.

(Signed) M. V. RICHARDS.

Washington, D. C., November 17, 1914.

The first paper read at the Thursday morning session was by Mr. C. W. Mengel, Drainage Engineer of the John L. Roper Lumber Company, of Roper, Beaufort County, North Carolina, on "The Drainage and Development of North Carolina's Muck Lands."

The Drainage and Development of North Carolina's Muck Lands

BY C. W. MENGEL, DRAINAGE ENGINEER.

It has been thoroughly demonstrated during the past few months that of all the various pursuits engaged in by mankind, that of farming, where each farmer produces on his farm all the products necessary for the maintenance of his family and his stock, and still has a surplus to place on the market, is the most independent, and is the surest basis for general prosperity.

At this time when the "back to the farm" movement is being agitated, and when without a doubt many who have left farms for the city, or were seriously considering that move, are coming back to the farms—it is indeed fortunate for North Carolina that within her boundaries there are hundreds of thousands of acres of the most fertile soil as yet untouched by the plow. I refer to the black muck lands of the coast section.

This type of land can be found bordering the Atlantic coast from the Virginia line to the southern boundary of this State, and the larger tracts are usually found at an elevation below 25 feet above sea level. Except along rivers, creeks, and their headwaters, the soil, as indicated by its name, has been formed primarily from decomposition of water plants, sphagnum mosses, and sedges, and as these decomposed they gave way to a timber growth of cypress and gum. Along the rivers and creeks bordering this formation, the soil is more alluvial in origin, and more firm in character. From these water-courses, which are naturally at the lower elevations, the soil becomes looser, and the deposit of muck becomes deeper, as the elevation rises. This deposit varies in depth from one to seven feet, and the muck is rawer or less decomposed, in the spots of the highest elevations.

On account of the fact that these lands were formerly covered with valuable timber, and also on account of the lack of faith in the quality of the soil, they have not until the last few years been subdued, and a start made to make them productive, agriculturally. Before they can be made a source of profit to the owners, the railroads, and before they can add any revenue in the form of taxes to the State and community they must be drained, developed, and settled by a good class of citizens.

DRAINAGE.

To produce the most lasting, and, consequently the most satisfactory results the development of our muck lands should be carried on in a comprehensive and thorough manner. Because of the fact that the natural wetness of the lands is the first barrier to reclamation it might be said that drainage is the most important step in the development process. Inasmuch as the lands are tributary to some river or creek, their drainage should first provide an outlet through this natural channel. This outlet should be so designed that whether or not the entire watershed is taken into a single Drainage District at one time, its capacity will be sufficient to remove all surplus water from the entire watershed, when it is ultimately organized into a district and drained. In order to accomplish this a careful survey of the entire watershed should precede any construction work. It can aptly be said that an "ounce of prevention," taken in the form of accurate survey data, will save "a pound of cure" from the troubles of shortsightedness. Whether or not all the land in the watershed is organized into a district at one time is, then, immaterial, and each district (if there be more than one) may proceed to completely drain the land within its boundaries by a uniform system of drains, inside the main drainage district. That right to perfect a drainage scheme by organizing one district within another has been upheld by a late decision of the North Carolina Supreme Court.

Experience in draining muck lands of other states has been that in order to secure adequate drainage for these lands, the main canals must have an effective depth of from seven to eight feet, and a dividing distance laterally

of not more than one mile. This experience has been paralleled thus far in the draining of North Carolina muck lands, and as a rule it might be said that the course is a safe one. These main canals which are tributary to the outlet or trunk canal, should be laid out uniformly, and in most cases they can be made parallel as the topography is quite uniform and will permit. This plan of uniform spacing of mains has the advantage in making equitable drainage assessments easier, and the land can be subdivided into uniformly shaped tracts where each form will have like advantage as to drainage and proximity to good roads, in case development for sale is the object.

The muck lands of North Carolina are underlaid with both sand and clay subsoils; these subsoils are found in different localities, and, as far as the quality of the top soil is concerned, no difference is found between that underlaid with sand and that underlaid with clay. With a properly controlled water-table, by means of properly spaced open drains, and tile drains, both are water-absorbing and drought-resisting to a remarkable degree.

The proper spacing which should be given to lateral drains in this soil is as yet an experiment as far as any exact knowledge is concerned. Practice in this regard in Eastern North Carolina varies from a minimum spacing of 330 feet to as high as 660, depending upon the crop and the degree of rawness of the soil. It is the opinion of the writer, however, that in order to guard against extremely wet years the spacing on ground where a variety of crops is raised, should not exceed 330 feet for either open or tile drains. It is highly probable that as the muck decomposes more and more the spacing of the laterals will have to be made closer.

While the muck is loose and contains more or less raw vegetable matter, the ground should be kept fairly wet and the water table high, as the extreme porosity of the soil at this stage does not give it a high capillarity. During this stage long-rooted crops should be the major crop, as they are less liable to suffer from a prolonged drought. The laterals, therefore, should not be deep at the start, and until the ground has been cultivated a few years, a depth for the laterals of more than three and one-half feet is not recommended. Experience elsewhere has shown that muck lands have been irreparably damaged by a lowering of the water table below the subsoil, followed by a very dry season. If properly handled at the start this difficulty will vanish, after a few years of cultivation.

Whether or not tile should be used at the start, as laterals, is open to more study. It is the opinion of the writer that tile can safely be used, if laid on a firm subsoil and arrangements are made by which the tile may be closed during periods of drought, thereby controlling the position of the water table. These muck lands when properly subdued and thoroughly drained can not be injured by any rainfall, as their storage capacity is very great, and on the other hand this same quality gives rise to a high capillarity which makes the most drought resisting soils.

DEVELOPMENT

The drainage of the lands having been accomplished the next step is their development. In this step the building of a system of good roads comes first. No argument is needed to prove this, for good roads have always been the forerunner of development. The system of roads must be designed to give every individual tract of land an outlet to the main highways. One part of

this system can be made easily by levelling one spoil bank on each drainage canal, which with proper working with a road machine will give a good solid, sand-clay road with perfect drainage. This can be done at a cost of from \$400 to \$600 per mile, or for a road on a minimum sized dredged ditch at an extra cost above the cost of excavation of from one and one-half to two cents per cubic yard of excavation. Cross roads at right angles to these can be constructed by ditching each side of the road, and scattering the excavated material in the center, there to be worked to proper shape by a machine. The roads of this type can be built for about \$800 per mile. If these roads are placed at mile intervals we will have a tract of one square mile, surrounded by a good road, and with perfect drainage facilities. The cost of these roads will amount to slightly over two dollars per acre to the land served.

The preparation of the muck lands for crops varies with the growth on the land. This is of two kinds—timber and reeds.

In order to make a crop the first year on the land on which timber is growing, corn must be raised. This is done by what is known as the "stuck" process, which consists in cutting the growth in the fall, burning it in when thoroughly dry in May and immediately thereafter sticking the crop among the stumps and logs. This process may continue for as long a period as four years, when the stumps and logs not burned are gathered and burned, and the land is ready for cultivation. By this process land may be cleared and the owner may realize a profit from the crops raised during the period of clearing.

The reed land must be cleared and cultivated at once, and though the initial cost is more than for a stuck crop on timbered land, there is the satisfaction of being able to cultivate it and raise on it a variety of crops.

The costs of these methods of development and the profits realized thereby have been discussed in a paper by Mr. J. O. Wright at the First Annual Drainage Association, and will not be dealt with in further detail here. It might be added that the first man to see the possibilities in draining and developing large areas of North Carolina muck lands was Mr. J. A. Wilkinson, an enthusiastic member of this Association, and the work done by him in the Pantego and Broad Creek Drainage Districts is a revelation even to the people of this state, who never dreamed of such fertile lands lying at their very doors.

The introduction of machinery into land-clearing operations has simplified a great many problems, which heretofore have seemed insurmountable, on account of the amount of labor involved, and on account of the cost being so high that the selling of the developed land at a reasonable figure was prohibited. As yet there are very few machines on the market for land clearing purposes, but progress is being made, and we can be assured that with the vast amount of unreclaimed land waiting to be cleared economically, machines will be perfected which will enable the work to be done more cheaply than formerly, and the lands can be put on the market at reasonable figures.

These lands, once developed, must either be sold to American farmers or be colonized by some thrifty foreign element. The former would be more desirable, but in either case these must be colonization from other parts.

To carry on this work of development requires a great amount of capital. The drainage costs can be covered by bonds issued under the authority of

our State Drainage Act. The development costs must come from another source, and financiers must be convinced by actual facts that money spent in development of our muck lands is a gilt edged investment. That there are a great many superstitions prevalent in the minds of outsiders as to the desirability of the lands and the healthfulness of the climate in the muck land section there is no doubt, and these rumors, coupled with an ignorance of actual conditions by a majority of people, will make it difficult, no doubt, to finance these projects until a more advanced stage is reached.

When the lands are developed the people sought after for settlers must be convinced (if we will reach the better classes) that they are to have the advantages of good health, good schools and churches, and that they will be welcomed as a part of North Carolina's citizenship.

Reports From Representatives of Drainage Districts

At roll call the following districts responded:

Broad Creek Drainage District of Beaufort County has been completed.

Conaby Creek Drainage District of Washington County has been dropped for the present.

Pungo River Drainage District of Beaufort County has been practically completed, with the exception of about one and one-half miles of widening the main channel at the lower end. (Report made by Mr. Mengel.)

Lyon Swamp Drainage District of Bladen and Pender Counties. Mr. Keith reported on this district as follows:

The district was finished about three or four years ago and has proven a wonderful success not only in the way of drainage, but it has put new life into the entire community and health has been perfect, you might say. Lands that were formerly woods are today very valuable—in many instances ten times as valuable as they originally were. We are producing all classes of crops there—corn, cotton, oats and wheat—we raise fine wheat there, also hay, peas, potatoes, and now we are just on the beginning of a new year of greater prosperity than that country has ever dreamed of. We are trying for good roads now, and when we get our good roads, with our good lands and our new school buildings (we have twenty new graded schools established), which are as great a stimulus to drainage work as anything else, we can say ours has been a great success so far and I have no idea but what it will be greater.

Moyock Drainage District No. 1 of Currituck County. Mr. Brett reported that the drainage district was finished and the land under cultivation.

Mattamuskeet Lake Drainage District of Hyde County. Mr. Chappell, engineer in charge, reported: About 40 per cent of the excavation work has been completed, and also about 22 or 23 per cent of

the mile of ditches. It will take eighteen months to complete the drainage. The erection of a pumping plant will begin in about two weeks and so far we have been very much pleased with the progress of the work, and the indications are for success. We have had less difficulty than we anticipated, and this was easily overcome.

Rocky Point Drainage District of Pender County. Mr. Becton reported that the work had gone on very slowly on account of rock encountered, but now it is practically complete and a good deal of land is ready for cultivation.

Parkville Drainage District No. 1 of Perquimans County is about 60 per cent completed and will be finished about the first of February.

Back Swamp and Jacob Swamp Drainage District of Robeson County. Mr. Sellars said that out of a total acreage of 35,000 about 95 per cent had been completed. The work had been very satisfactorily done so far and they expected good results.

Pitt County Drainage District No. 1 of Pitt County. The surveys and engineering features have been closed up. The people are anxious for the drainage.

Wayne County Drainage District No. 1. The work has not been completed on account of lack of money—about \$6,000. This district has been an incentive to the organization of other districts throughout the county.

Wayne County Drainage District No. 2. The length of this district is about thirty miles and estimated acreage seven thousand. This district was started about ten years ago by correspondence with Governor Aycock. There are no legal objectors in the district. The next thing to do is to sell the bonds and get a contractor to do the work.

Wayne County Drainage District No. 3. Major Peirce. This district is about ten miles long and contains about three thousand acres. No objection has been filed on account of three of the largest landowners. When you have two or three big landowners objecting to it and they have money to employ lawyers to fight this drainage law and resist every move you make, you had better use a little diplomacy and get that fellow to go in friendly before you file the objection. Last week I spent one-half a day with a man trying to persuade him to come in, and he said: "Do you know whether that land will be helped? Suppose we wait two or three years and watch some of these districts that have been completed and see if the fertility will be increased. It has been soaked so long in water that I think the bottom will drop out and nothing be left to it." Of course I told him the fertility of the land would be greatly increased.

The President of the Association made a plea that the drainage dis-

tricts be named according to the county in which they were organized and in order of the organization; as for instance, Wayne County Drainage District, No. 1.

Following the discussion of the drainage districts Hon. John H. Small, of Washington, N. C., made an address on "North Carolina Drainage Law and Some Needed Amendments."

North Carolina Drainage Law and Some Needed Amendments

BY HON. JOHN H. SMALL, CONGRESSMAN FROM FIRST NORTH CAROLINA DISTRICT.

Mr. President and Gentlemen:

I am going to ask you to let me browse about a little this morning, and not confine myself to North Carolina Drainage Law and Some Needed Amendments. Amendments to our law, just as the original draft, require very serious consideration. We cannot discuss them in a proper way—and certainly you cannot frame them in a way which will make them legal and consistent with the existing drainage law. I see in the morning papers that there was some discussion yesterday of needed amendments—one of them by my neighbor, Mr. P. H. Johnson, of my own county. I believe that the subject of these amendments ought to be considered by the committee who will give to it sufficient of their time, directed by an intelligent study of the law, and that they shall have the cooperation of the practical men connected with the drainage of our wet lands; because the actual putting to a test of any law, as in the drainage of lands, reveals its weakness, the points of amendment which are required and the strengthening of it in order to make it more effective.

While I have several points in mind, there are two or three which are particularly necessary, as coming under my own observation. One of them is the lack of any provision in the law for transferring the tax from the grantor to the grantee. Now there ought to be a provision of law by which the grantee of that one hundred acres shall know and shall become bound for the burden of the payment of the annual assessment, arising out of the transfer of ownership. That has arisen very frequently in the districts in some of the lower counties where lands reclaimed were owned by one person and transferred to another, and in many instances the reclaimed lands had not been previously under cultivation. My friend, Mr. Johnson, I have heard speak a number of times about increasing the tax at which land should be valued. I do know that in some instances viewers have said as to a certain piece of land that you cannot benefit it * * * that it would not be as much benefited as another tract of land which he had placed in the lowest class, and yet it ought not to escape entirely its burden, because it will receive some benefit. On the other hand, lands which are greatly benefited and placed in the highest class are not as greatly benefited, or are a little less benefited, as some lands which also are receiving or will receive the highest benefit by the process of drainage. So that I think an enlarging of the number of classes for the division of land and classifying the benefits might well receive the attention of the Legislature. I am not going to detain you longer to talk about amendments. I had the honor of being in some degree responsible for the drafting of the original law of 1909; in fact, I took a lot

of rough material and put it in shape; and in that shape it was enacted by the Legislature. I also spent some time, more than a week altogether, over the preparation of some amendments and sent them to the Legislature of 1911. Some of them were discarded, which I think were valuable and might well receive the attention of subsequent legislatures. I mention that point, not in any spirit of egotism, because I have done no more to serve this important movement than many others have done, and are willing to do, but because I do wish to emphasize the point that these amendments must receive careful consideration from two sources; practical men connected with drainage of the lands and at least one or more good legal minds who will see to it that the amendments are consistent with the existing law and in themselves shall be entirely legal and workable.

I am willing, Mr. President, to assist in this, for it shall be my pleasure, and the pleasure of the Drainage Association, to coöperate with the committee which will endeavor to frame the necessary amendments to be presented at the next session of the General Assembly.

Now, Mr. President, I want to do that browsing for which I asked permission, and to talk just a little about this general movement for drainage. We hear and we read a great deal about progress. We refer to it in connection with certain communities as being progressive sections. One state is making progress more rapidly than another state. We refer to our great country as the United States, describe the progress it has made, and its comparative relationship to other countries. The world for twenty years has been talking about the progress of Germany, which has really been wonderful, but while the press as noted in our current literature, our newspapers and periodicals, is largely concerned with this question of progress of nations and states and countries, you cannot separate progress of the state from the people who live in these communities and who constitute the citizenship of these states and plan their government. While natural resources are greatly to be desired, while the different sections are to be congratulated on their topography, their soil, their climate, their forests, or their mineral wealth, some offer advantages which are not possessed by others; yet after all the proposition may be laid down without the slightest fear of contradiction that no matter to what extent any section of country may be blessed with all or part of these natural resources, unless the right kind of folks populate that community and these sections of countries, these natural resources will not count for progress. I feel that we may this morning indulge in self-congratulation in that we are coöperators in a line of work which makes for genuine progress.

It takes many elements and factors for a complete civilization. We are proud of the churches; we take great pride in this propaganda which we have urged so consistently for the upbuilding of our public schools, so that every child, no matter how humble his birth or parentage, may have the advantages of a common school education; we have reached that stage in this state where we believe that every boy and every girl is entitled to a chance. So, we are proud of many other movements which make for higher ideals, for better morals, for a clearer spiritual insight into ourselves and into others, and into problems which increase and widen our horizon. Yet, after all, it is the material progress which a people make which must be a forerunner to every other variety of progress. You cannot progress unless these resources are utilized and developed for the well-being and up-building of humanity.

While one of the apostles said it was through the foolishness of preaching that men may be saved, yet even the churches must be supported, and no community will find it possible even to maintain a good church which will properly serve the Master without a spirit of coöperation.

I do not know how it impresses you, but, as a boy, and frequently since then, I have tired of the premium which is too frequently placed upon poverty. I have heard too many good preachers talk as if poverty was the one true, unerring road into Paradise. If it is necessary for a person to be poor; if in spite of the utilization of the best intelligence and talents of a man or woman, they are poor, they should not be criticized; but poverty, when it is due to ignorance, narrowness, want of capacity or lack of ambition to improve the opportunities which they may have, instead of being an object of merit, it is an insignia of disgrace and it does not fit any man better to serve the churches or to serve himself or to travel in the straight and narrow way. You cannot separate the material progress of a people from their general progress, because all these movements which make for higher ideals in life, must have as a concomitant contemporaneous with them a people who are progressive along material lines in order to give force and fact to this spirit of moral ideas. As we go along progressing, as we get from time to time the finer type of civilization, the individual as an individual becomes of less relative importance and the individual in his relationship to other individuals becomes of greater importance, because the finer the civilization of a community or state, the more is coöperation needed between these individuals in order to bring about the welfare of the people. For many years, in fact, for a century in North Carolina, as I read our history, we have emphasized individualism. Perhaps that was right in the early days when the dominant thought in the minds of the people was the construction of our basic laws, the preservation of individual liberty pointing constantly to our Magna Charta. The fact that during that earlier period men could more nearly live alone than they can today, perhaps from necessity and the natural training of conditions, it was altogether proper that the individual should be emphasized during that period; but for some years we have been gradually approaching that condition where the very best things for our welfare and happiness and contentment and prosperity require that men and women should join hands. It is true we must have leaders in every movement, but for a man to lead, whether it be in the church, in the good roads movement, in politics, or any of the activities of government, that man cannot lead until he has first learned to serve. I do not quote it literally, but there is something in the Good Book substantially like this: That he who would be chief among you, let him first learn to serve. It was said by one of the Governors of Massachusetts on one occasion that he considered one of his greatest successes in life was due to the fact that he had learned to work singly and in harness. And I say that every man who would be a constructive leader in his community and stand for the things that are righteous and make for individual and community welfare must first have incorporated into the warp and woof of his being the spirit of service to others; because a man who has not learned that cannot lead others in a coöperative movement in which all are engaged in a common service unless he himself knows how to serve. One of the difficulties of every movement which is inaugurated for the common welfare and in which each individual is interested is in obtaining their

coöperation. Every one knows about that wonderful movement for public education which has now been carried on in our state for a number of years; how difficult it was to get our people away from the idea that it is the duty of each parent to look after the training of his own children, and that he had no duty towards his neighbors! How difficult it was to get men to understand how at the base of that idea of public instruction was getting him to be willing to work together with his fellows and provide school facilities for all of the children.

We have had bad roads in North Carolina for a hundred years, but under the leadership of progressive citizens representing the communities and counties we are making wonderful progress in improving our highways, and this has been accomplished under the greatest difficulties. It has been done by impressing upon the people in the townships and counties, which are the proper unit—I say in impressing upon the people of the townships and counties—if we would have good roads it is the duty of every one to contribute in proportion to the extent with which he has been blessed his quota for the construction and maintenance of good roads. It is true, as in all other undertakings, a great difficulty was encountered in the ignorance of the people. Ignorance constitutes the barrier which blocks the way to improvement and progress in every direction. The main difficulty after you have convinced a man of the need of a certain improvement, after he has gotten at least a working idea of the method by which that improvement shall be brought about; the great barrier which has been confronted in every instance has been the difficulty in convincing him that he must join hands, and work together, in sympathy, with intelligence and in charity, with all others who are willing to engage in a common undertaking with him.

Now I said we are to be congratulated in being in attendance upon another annual meeting of the North Carolina Drainage Association. It is not the only pebble on the beach among the constructive movements in North Carolina, but there is scarcely another which is of greater importance. We are taking an asset of comparatively no market value, of no productive capacity, or the productive capacity of which has been greatly impaired by conditions, the conditions being the presence of too much water; and we are adding double, treble, and four-fold to the value of that asset because we are increasing its productiveness; and, if this Association and its friends and co-laborers in North Carolina shall continue to stand together, having as their ideal the drainage of all the wet lands in North Carolina, with the intent that they shall be so effectively drained that they will make good crops every year, it will have added to the wealth and profit and welfare of the people of North Carolina I believe more than any other one movement in this great march of material progress in which we are engaged. Coöperation is the prime factor here. I was very much interested a moment ago in the statement of Mr. Peirce about the several drainage districts of Wayne County. His report was a reflex of that which has occurred in every other drainage district. He spoke of the difficulty of getting uniform agreements among the landowners of the drainage district and of the inadvisability of pushing them too hard until you had exhausted every effort to convince the doubters, the skeptics, the men who hold back that it is their duty to join in the establishment of such a drainage district. That simply illustrates that one of the reasons why there are so many hundreds of thousands of acres of land in North Carolina, so

many of which are not in cultivation and some of which have not been in cultivation for a century or more, have never during that time been efficiently drained and have every few years, according to the common expression, been "drowned out." That very difficulty explains that condition here in North Carolina because in the past our individual landowner has claimed the privilege and the right and the power to drain his own land, regardless of his neighbor. It is true, you must realize that it is impossible for the individual to drain these lands by himself, and so we have had ditch laws enacted by our legislators from time to time; but their very inefficiency has been proven time and again by the fact that through them we were not able to drain land in any economical manner, and it is because we realize that the individual landowner as the unit in the solution of the problem of drainage will not drain our wet lands in North Carolina that our Legislature, at the insistence of some of our people, have enacted the present drainage law which has enabled us to translate into action this disposition of the people to coöperate and to drain their land along with their neighbors' land, because it was impossible to do otherwise.

I know, Mr. President, that this is old; I know it is a truism to talk about the necessity of coöperation; I know that each man will say that he appreciates the duty he owes to his fellows; and yet, as a matter of fact, other intelligent men here know that this barrier still exists as a bar to the more rapid progress of the drainage movement, and that the nearer we come to striking down this barrier and creating in the minds of owners of wet lands in North Carolina that it is their duty to join with their neighbors, their contiguous landowners—the nearer that is done the more rapidly will we advance and the more drainage districts will we organize.

I go about among the people on the farms at every available opportunity. I love to do so, because you can become better acquainted with a man by his own hearthstone and understand his life better in the presence of his family and he will come to know you better than under any other circumstances. I think I know the people of eastern North Carolina in a number of our counties, and their many characteristics. There are no finer people to be found anywhere than here. They have inborn in them the spirit of charity and benevolence. I doubt if there are any people in the world who, in the presence of sorrow, suffering, disease or death, can be appealed to with the assurance of a more generous or ready response than these people of eastern North Carolina; and I think I can speak for the whole of the state. And yet, as a rule, if there is a public question affecting our whole state, I realize that our people to a degree are narrow and constricted in their views, and are sometimes lacking in the generous spirit of coöperation with their neighbors; are distrustful when it comes to joining hands for the success of a movement and that too frequently all of their good qualities are forgotten in the solution of these public questions. The citizens of communities and counties of the state at large need to cultivate this spirit of kinder service in coöperation, which can only operate to their good. I believe, taking each one of us separately, we wish to do all in our power to further this drainage movement, taking it for granted that in our respective communities we are willing to get behind any movement for the public welfare; and I do not believe that we can accomplish a higher service than by constituting each one of ourselves as missionaries to go abroad among our people to preach this doctrine of

coöperation, each in his own community, and to show them by our daily lives the generosity which should animate such a spirit. And then, in so far as we can, preach the gospel of service to the people among whom we live. That is the great thought I had in mind, Mr. President and gentlemen of the Association. I hope that the life of this Association will be indefinite. I hope that so long as there is an unreclaimed area of wet land in North Carolina that this Association shall be an active force for its drainage, remembering as we must do that not only should we drain the unreclaimed swamp lands and timber lands which have been cut over; but that there is a very large aggregate of land which has been in cultivation a number of years and which has its value impaired because it has not been properly drained. So long as unreclaimed lands are undrained this Association will continue its activities, to the end that the ideas of the Association shall be carried out.

Just this thought, and I will not trespass upon you longer. Not only is the drainage of our lands necessary in order to make them more productive, but I am sure that I will not bring you any new thought when I say that drainage of these lands is necessary in the conservation of the health of our people. I was born and have always lived in eastern North Carolina. It is a section of the state which has always been regarded as unhealthy. I was talking with a young lady in my town yesterday who said she was born in Rockingham and her people were very much averse to her coming down to the low country. Part of this fear is justified and part is unjustified. But you can kill a man by frightening him almost as successfully as you can by bludgeoning him, and this dread of malaria in eastern North Carolina among those who live in a higher elevation or those who come from other states has been one of the most serious drawbacks to the development of tidewater North Carolina during all its history. We have studied malaria. Men of science have given their lives to it, and one fact has been thoroughly demonstrated, and that is that the mosquito carries the infection of malaria, or the malarial germ. When it bites a person suffering from malaria it takes up the germ and then if he bites a well person, unless such person is strong enough to eliminate the germ, that man will become a victim of malaria. We know the only effective way to eliminate the mosquito is through drainage. If our farms and a reasonable space from our homes are free from stagnant water of any kind, and if we have in addition screened houses, we can avoid malaria just as successfully as the person living upon the highest elevation in the mountains of our state; and if there is one movement which is more successful today than any other it is this world-wide movement for the conservation of the public health. No matter how Mr. Rockefeller gives his wealth and I am no sponsor for him in any respect and have never seen him, yet I thank him for that donation for the eradication of the hookworm from the south. That hookworm commission not only in its attempt to eradicate that disease, but in the eradication of many other diseases affecting our people, has made it possible, through the liberality of our own Legislature in the establishment of a State Department of Hygiene, a continuation of this great work in the promotion of the public health, and has greatly lessened the mortality in our state.

Looking back, as a boy, I recall the time when I saw men in our town who were pointed out as being absolutely worthless. They were indolent and absolutely counted for nothing as a factor in life. They were criticized, they were

blamed, they were ridiculed. I realize now that these men were the victims of hookworm or of malaria, or both, and with this thought about health, which I express about other movements, I am going to close. That great question which thrilled humanity at the beginning of our race, "Am I my brother's keeper?" applies to this question of the conservation of our public health. If we, by neglect and indifference and failure to engage in the common service for the benefit of humanity, fail to participate in these movements which make for the conservation of the common health and thereby our neighbors become diseased, we who are intelligent and are blessed and know our duty and have failed to discharge that duty, have in our own consciousness or at the bar of judgment no claim to absolution. There lies at the very root of all these upward movements which make for the benefit of humanity a spirit of service and a disposition to coöperate.

The President of the Association made the following suggestion:

While, perhaps, there is no particular amendment up for discussion, yet any suggestion from any of the delegates regarding what they consider necessary to make the North Carolina drainage law more effective and more operative are now in order.

I would make this suggestion, myself, that any of you who have or feel that you know of some changes that should be made in the North Carolina drainage law and you do not feel like trying to give them here, if you will write them out and then send them in to the chairman of the Legislative Committee they can be considered carefully by that committee. I might say that the Legislative Committee acting now is the one that the President appointed at the Charlotte meeting and that held over through this meeting; and that another committee, or the same committee enlarged, will be either appointed or continued for the coming year. The Legislative Committee this year has hard work before it, because of the meeting of the General Assembly in January, and we want our Legislative Committee, which does represent and express the opinion of the Association, to have drawn up and ready for introduction into the General Assembly of 1915 a bill that will express the amendments that we believe are necessary to make our North Carolina drainage law more effective and more operative. That committee will be asked by this Association to draft such a bill, and not only draft it and have it introduced, but go to Raleigh and explain to the committee—either the Drainage Committee or the Committee of the House as a whole—why they believe these amendments to the North Carolina drainage law should be passed. I believe we will find that the General Assembly of 1915 will consider the suggestions of our Legislative Committee as the highest authority on drainage matters in North Carolina, and will adopt such suggestions as are made by that committee. You know as well as I do that it is not sufficient simply to have a bill introduced into a General Assembly. You have got to get back of that bill—you have got to have somebody in the House and Senate, especially in our drainage matters, to get back of that bill and then we as an association have got to get back of our Drainage Committee with the members of the House and Senate, and assist the committee in every way to explain why such legislation should be passed.

I think sometimes in trying to have a bill go through the General Assembly it is like trying to keep business up in merchandising or manufacturing.

There was a time when a merchant or a manufacturer could sit in his office and by simply sending out notices that he had such and such a thing for sale he could sell them, but now he has got to go after trade, and so it is that we get legislation through. You have got to have someone familiar with the legislation desired, some one who can explain and recommend it to the Senate or to the House, and that is what this Association will ask of its Legislative Committee. I was very glad Mr. Small brought out that question or point, that he hopes this Association will appoint a Legislative Committee that will be willing to serve and give the time necessary to secure the legislation desired.

I want to say again that before any bill is introduced it ought to be gone over so carefully and minutely in every detail of language that there will be no question as to its legality, no question about phraseology, and the men who introduce such a bill in the Senate and House can stand by and say emphatically: "We want it passed without any changes or amendments at all." I believe our Legislative Committee will, as they have done before, put such a bill into shape, and the men in the Legislature interested in drainage will get back of that bill and see that it is passed as recommended by the North Carolina Drainage Association. Such a committee will be appointed by the President of the Association and be requested not only to draft or draw the bill, but to go to Raleigh, appear before the Legislature, and explain the reasons why it should be passed.

Mr. Peirce made the following suggestion:

As we stand now we are an independent organization, a private organization. We are without the assistance or help of the state except through the assistance we get from Dr. Pratt, as State Geologist. Of course, as President of the Drainage Association, and as President of the State Geological Survey, he has given us a great deal of assistance, but we are without the coöperation of the state. Now the law says that when we make this preliminary survey it shall be approved by the clerk, by the State Geological Survey, and then the Commissioner of Agriculture shall pay this money out from the treasury, but where they have made these payments and the districts organized and bonds sold they have not gone back to these districts and asked that the money be refunded to the state, so they could help organize and promote another district, but they come back and say, "We have no money available for that purpose." A. and M. College, and other sources, have taken this money. Now it seems to me we ought to have in the state a Drainage Commission. We have an Insurance Commission, a Commission of Agriculture, a Corporation Commission, and I say we must go to the Agricultural Commission and ask them to assist us in this way, and we are thrown off. It seems to me that in time we ought to have a Drainage Commission and let that be part of the organization of the State. The Supreme Court has held that these drainage organizations were private organizations. It seems to me we should arrange some way so that we could have these engineers under a Drainage Commission to do this work. Or the law ought to be amended to the effect that Major Graham or the Treasurer shall have that money in such shape they can supply it to districts when needed and some means of forcing the districts to return it at the proper time.

Another point is—I think we ought to get behind our legislators after these laws have been amended by this Committee and go up there in person if need be and see that they are enacted. Of course I am not a landowner, but I am interested in this drainage from a personal viewpoint. I would like to help the district and I feel that other attorneys would, too; and while we do not get much money out of it we hope to in the end. If I can be of any benefit in that way—going up there before the Legislature—I shall be glad to cooperate with you.

Another man: I would like to say further that I have had a conversation with the Commissioner of Agriculture along the same line. The Act of 1911 provided that with certain papers approved by certain parties, that any sum of money up to \$2,000 in one district shall be paid out of the funds in the State Treasury to the credit of the Agricultural Department. As a matter of fact the State Treasurer never seems to have this to the credit of the Agricultural Department unless the Commissioner of Agriculture sets that sum aside for this specific purpose. The law is one thing and the state keeps books another. The State Treasurer is merely treasurer *ex officio* for the Department of Agriculture, and unless there was some way to force the Commissioner of Agriculture to deposit that \$15,000 as set aside in the law * * * to provide these funds when called for, that law is ineffective. I think there have been \$11,000 advanced by the Department of Agriculture, out of which \$7,000 has been paid back. The other \$4,000 is still in litigation; so the Department of Agriculture, to comply with the law of 1911, still lacks \$11,000 in the State Treasury to further this drainage movement.

Dr. Pratt: At the beginning, as just brought out, there was no money in the general treasury to the credit of the Agricultural Department that could be used for this purpose; but, after the question was taken up with the Commissioner of Agriculture, arrangements were made by which approximately \$10,000 was set aside by the Commissioner for that purpose, and the understanding was that that money was to be used over and over again; but there was a difficulty experienced after that money had been loaned to the district. I have no authority at all as State Geologist regarding this money—and I went before the Commissioner of Agriculture and he said he had no authority to have it paid back. The Treasurer said he had no authority to try to recover or have paid back that money to the general treasury. The Attorney General said he had no authority. So it has been four years since the law was passed and there was no one who considered it his business and authority to demand that the money be paid back. There was approximately \$7,000 of that which was loaned that has been paid back. I think the total loan approximated between \$11,000 and \$12,000, out of which \$7,000 have been paid back; and according to the spirit and letter of the law should again become available to use to advantage in other districts. Now I have signed, I have forgotten what the total is, but I have to sign and approve the payments made out of that fund * * *. The last signed have not been paid. I do not know whether that \$7,000 went back to the general Agricultural fund to be again drawn upon by the Department of Agriculture for specific purposes and that the commissioners will have to again designate that a certain amount was at the disposal of the State Treasurer, to be drawn upon for this particular purpose. That is a point I think well brought out, and we will have it considered by the Legislative Committee, to see if they can in some

way have that particular clause in that second section modified or amended so it will definitely stipulate who is to see that the money is put back into the general treasury, and when it is to go back, so as to become at the disposal of the State Treasurer to be used again. That was the idea in the beginning, that \$15,000, if made available, would be sufficient to keep up the preliminary surveys and engineers' charges in connection with the drainage districts as they were organized. After the law was passed they passed a law that the State Geologist would pay expenses of drainage districts to the amount of the \$15,000, taking the entire appropriation of the State Geological Survey for that work. You can imagine that the State Geologist did not consider he had authority to pay. In the same year that that was designated, the Legislature also imposed upon the State Geologist other debts that required approximately from \$25,000 to \$50,000, making a total of \$60,000 or \$70,000 to be paid by the State Geologist out of a \$15,000 appropriation. Some of the work had to be left out. I would like to second the suggestion made that this be referred to the Legislative Committee, and they take under consideration that particular section to see if it cannot be modified and the money cannot constantly be put in the State Treasury, and the same \$15,000 be used over and over again.

Mr. Thompson: I would like to speak along this line. It seems to me that the greatest need now before the districts is to give additional security to the money they try to borrow. Three-fourths of the districts in the state are small districts. They are worth \$25,000 or less. It is difficult to go outside the state and get that much money to drain the districts. A number are unable to proceed because they cannot get money locally. Districts are being formed rapidly in the state and with the splendid forms that Dr. Pratt has gotten up for us the organization is very much simplified. That brings us up to the point of going ahead and doing the work. The lands are good for it and we get six per cent investment. There are a good many folks in the districts dissatisfied with the progress made in selling the bonds and risks are taken in making sales. There is not much money idle in North Carolina. Unless the local banks are interested it is very hard to get it, and I think we ought to provide some legislation to give such security as will make them attractive to bond buyers. If we can get the county commissioners to either approve or endorse the drainage bonds, I believe it would make them more salable. If they had that spirit of coöperation Mr. Small was telling us about, they ought to help the drainage district in their own county, and they would be more vitally interested. I think some legislation along that line is especially needed for the smaller districts. We have seventy-two districts, I believe, and I do not think there have been probably more than eight or ten of these bonds sold outside of the State; so we have to look to the banks of the state to get the money to do this drainage work.

Colonel J. B. Sellars: In regard to the first payment of bonds, it seems to me we ought to have at least one year intervening between the time for these payments. That is one weakness in our law. I never saw a bond issue in my life collected all at one time. I offer that as a kind of suggestion. Dr. Pratt, I do not know just the condition in regard to the bonds of the Back and Jacob Swamp Drainage District, but in 1911 that point was brought up and the drainage law was amended with that particular point in view, that the first collection shall be made in the fall of the year before the year of the

first assessment or first payment was to be made, so that there would be no question whatever about the interest and assessment being ready when the first payment became due. As in this 1915 payment, assessment was not really to be paid until the 1916 assessment and interest came due. That was the question raised in connection with the amendment in 1911.

Mr. Brett: I think under the present law care is taken of this first payment, and the tax rolls so made out that the tax becomes due when the first payment is due. For instance, a bond issue due March, 1917, the tax is collectible the September before. In other words, instead of having it become due in September, and your bonds payable in October of the same year, just push your tax roll forward one year, as far as its due date is concerned. I would also like to take up the point made by Mr. Thompson. I think we have ample security as far as the drainage bonds are concerned. I have marketed a number of drainage bonds, and even now right in North Carolina among leading bankers a North Carolina drainage bond is considered one of the best securities we have to offer. The only reason it does not find a ready market is that our laws are antiquated and tie up their hands so that they cannot invest except in certain securities.

I do not think it is necessary to amend our drainage law by putting other paper behind it. We have the land behind it. Since we have had the amendments put in our law that compels the sale of land on certain specified dates, we have had very much less trouble in selling it. There is one point which Mr. Thompson brings up and that is little bond issues. It costs the buyer just as much to investigate the small bond issue as the large ones. Consequently, when you are selling a \$15,000 bond issue and the bank wants to handle it at a profit, they have to buy a great many at one time, or else the expense of one issue is prohibitive.

Mr. Small: I would like to supplement what Mr. Thompson and Mr. Brett have said. I agree with Mr. Brett that there is scarcely a better security than that behind these bonds, subject to one condition. You cannot sell bonds unless they pass the scrutiny of a trained lawyer. None of these trust companies or banks will buy them unless they have been examined and approved by some lawyer who makes a specialty of that class of work and of acknowledged reputation, and they will not approve them unless the law has been scrupulously complied with in every detail. If there has been some omission perhaps in the posting of notices or advertisement or some other slight detail neglected and under the decisions of our court that would be regarded as necessary * * * and under some conditions would not be considered essential, yet you might point out this to one of these specialists and they would tell you that they must see the district formed in compliance strictly with the law. It does not mean the lawyer with the biggest reputation in the county, because lawyers with the biggest reputation are frequently not careful with the work they do. They are not good office lawyers. They are inclined to overlook little matters. But a lawyer who knows the law and will take the pains to see that every condition is complied with is the kind of a lawyer you want in the organization of a district, so that when your bonds are put on the market there will be no question as to their legality; otherwise, you will have trouble and a great deal of work to do the matter over again.

Mr. Thompson: Supplementing Mr. Small's remark would say that there is one specialist in the United States who makes a specialty of drainage bonds and many companies will not take the bonds until he has passed upon them, and he has suggested a number of changes in our drainage law.

Mr. Brett: Take into account that a hard and fast rule for the election of drainage commissioners would hardly apply in that the same conditions do not exist in each district. Each district is an organization of owners of land to bring about specific things. In one district the leading tenant may own five acres out of fifty thousand. In another, the leading tenant may own forty thousand acres out of fifty thousand. So far it has been the custom for the clerk of the court to establish rules for the election of drainage commissioners governing each particular district, not trying to set any form of rules to cover the whole state. One difficulty appears to be in providing no way for drainage commissioners to be elected and possibly we might outline, in a way, how he can be elected, so there would be something like uniform procedure in all cases.

Mr. Pratt: I believe that it would not be necessary for a man to come and vote personally, but by proxy. I understand that in some districts they refuse to let them vote by proxy.

Mr. Johnson: A resolution that was prepared last night and that will be submitted to this Legislative Committee will, I think, meet that point somewhat—especially his allusion to the termination of office. I am very much interested in that part of the program myself, and in this resolution it provides that after the district has been completed and the assessment rolls all filed with the clerk or sheriff that the term of office of the commissioner shall expire within one year and thereafter an election shall be held each year to either reelect those commissioners or their successors, and I believe that will be helpful. A man who is not sufficiently interested in the administration of a district in which he owns property to come and vote is not worthy of very much consideration.

Now I want to tell you a story. I live in a very small town; we have a postoffice, a grocery store, etc. In my township we have three drainage districts, embracing about 80,000 acres of land, or about one-third of the area of drained land in the state, which has been completed, as I understand, and this law has been instrumental in causing the investment of hundreds of thousands of dollars in the development, clearing and cultivation of thousands of acres of land, and all of this swamp land is estimated to have been increased in value at least 75 per cent. While this organization, I think, is something like eight years old now, and while we have done more than any other part of the state in one particular section to follow this law, we have never yet had this Convention assemble with us, and I think it is peculiarly fitting that this Association should meet in our community next year. I want to read a letter that I have from the secretary of the Board of Trade at Belhaven.

BELHAVEN, N. C., November 17, 1914.

To the President and Delegates of the North Carolina Drainage Association at Wilson, North Carolina:

GENTLEMEN: At a meeting of the business men and citizens of Belhaven, held on Monday night, the 17th inst., a resolution was

passed sending a very cordial greeting to the North Carolina Drainage Association; and a pressing invitation to hold its next annual convention in Belhaven, North Carolina.

The Belhaven Board of Trade heartily joins in the resolution. We wish for your Convention a success and a realization of your desires.

Yours truly,

BELHAVEN BOARD OF TRADE,
Per Frank Snyder, *Secretary*.

We want you to come. We want you to visit this City by the Sea, where you get the sea breezes, and we promise you that you will find the doors all open. We want to take you there in a flat-land country, where the sky is bluer and the soil richer than you ever saw, and we think when you stay there a while you will agree with us that we have God's country in North Carolina, and that the further east you go, the nearer you approach your Creator.

Mr. Small: I would like to supplement what Mr. Johnson so attractively suggested about Belhaven as the next place of meeting, and to add a suggestion. We usually have our meetings in November. They have as fine oysters there as can be had anywhere—it is near the oyster ground—they are right at the door-way, and the finest fish anywhere. I do not know of a more delightful view anywhere than in front of Belhaven. You will have an opportunity of being taken through these drainage districts and you will be delighted to see good roads, great canals, nice farm houses, and improvements made on land which before being reclaimed was a perfect morass of weeds, undergrowth, large timber, and frequently water from one to several feet deep, from mountain rainfall. And there is one other attraction: You have heard one of the gentlemen this morning describe the Mattamuskeet Lake District. That is the most unique diking district in the United States—in some respects the largest. You will never have an opportunity to hold this meeting at a place nearer that great drainage district than Belhaven. The people there, I know, will be delighted to take you in their motor boats to Swan Quarter, to Juniper Bay, near the great Dismal Swamp Drainage District, and there you will have an opportunity to see all this next November. So if you want to hold a drainage convention right in the midst of drainage improvements of the most unique and interesting kind, I hope you will accept the invitation that Mr. Johnson so graciously extended.

Adjourned to 2:30 o'clock.

AFTERNOON SESSION—Thursday, November 19

Mr. Lawrence Brett, Drainage Engineer, made an address on "Some New Factors in Drainage Work in North Carolina."

Mr. President, and Ladies and Gentlemen of the Convention:

It has always been my good fortune, or perhaps my ill fortune, at these conventions to speak right at the end of the program, when everything that I have prepared to say has been said by someone else in a much better way than I could say it myself. However, there are a few points left that perhaps have not been discussed, and I will have to treat them in a more or less extemporaneous manner. What I have prepared to say has been said and I know you will not want to hear it over again.

The work of the North Carolina Drainage Association was founded upon the sentiment of the progressive people of the state who realized the need of drainage. They found they had no way to coöperate and secure what they needed in the way of relief from swamp land conditions or overflowed conditions. This sentiment called for the organization of the North Carolina Drainage Association, which was organized in New Bern in 1908. The first meeting of the Association framed through its committees the North Carolina drainage law under which we are operating today, with some amendments.

In 1909-1910 this law was first put into effect, and in 1911 we found that certain amendments were necessary to make the law more applicable to the conditions under which we have to operate. These amendments were made, and since then the law has worked probably a good deal better than at first; however, we realize that our law is still far from perfect, and that we have a good many things to do to improve it. A good many points have been discussed at this convention in reference to amendments to the drainage law. These matters have been considered carefully by the Legislative Committee, and I think in time we will develop a law that will be as near perfect as any law can be.

Now, all these points have been at different times new factors in the drainage work of North Carolina. At the last meeting of this Association and next to the last meeting, which was held in Raleigh, we first began to discuss what we will do with our swamp and overflowed lands, once they have been reclaimed. The problem of settling the lands is one that has taken a good deal of the thought of those engaged in drainage work. The drainage engineers and landowners have been interested and all who have had to deal with drainage work in any capacity have been interested in what we will do with the lands. We have solved most of the problems in engineering; at least we know we can successfully drain the land; our agricultural people assure us that we can farm them at a large profit; but who is going to do the farming? This problem of settling the lands has been a very serious one.

At present there are six large development companies operating in North Carolina who propose to bring settlers to the swamp and overflowed lands. The entrance into the drainage field of these development companies, in my opinion, marks a distinct advance in drainage work, as it brings in a different viewpoint from that from which we have been observing the problem. This year I have had occasion to be connected with three different enterprises of the six in one capacity or another, and I find among those interested in these development companies no spirit of competition. What they all want is to bring people into North Carolina, and if one development company cannot sell them land, perhaps the other can, and each sale is an advertisement of the rest; consequently, with no exception, there has been the most hearty coöperation among the six companies selling land in North Carolina. Most of these are coöperating, not by actually getting together and discussing plans, but by aiding in every way possible all of the projects and all of the publicity that can be given to drainage work in North Carolina. Some of these companies started up by draining their lands first and bringing them into cultivation, and then offering them on the market.

One of the distinct advances of this nature has been the entrance of a large company from the west. They started in, not as an engineering organization, but as a sales organization. They had a well-organized sales force to sell land and they had the land to sell. The drainage problems were taken up next

and solved with a view actually of subdividing that land and selling it. The sales force kept pace with the work that was laid out and planned, and before any construction work was done they had already sold to settlers nearly twenty per cent of the first 25,000 acres they are now starting to drain. I look for much future activity in drainage work in North Carolina.

The terrible European war, which is now attracting the attention of the world, will, I believe, when it is over, mean a gradual increase in desirable immigration to the United States. Those of us who have swamp land to offer at a reasonable figure and in such shape that a man can come in and farm on it, will find no lack of desirable citizens to occupy it.

We have, as we have said, solved the problem of draining the swamp land. When we first commenced to discuss this question at our meetings there was a great deal of pessimism shown in the remarks that this and that could not be done. While we may have no opportunity to answer all those who offer objections to drainage propositions, every drainage district that has undertaken work has gone on with it and successfully completed it. We have actually drained every swamp and every area that has been undertaken, and now that this has been done the supposition that swamps cannot be drained is no longer heard. We know we can drain the land to give it the outlet or main drainage, and lateral and tile drainage are bound to follow.

I look to see as a new factor in the work of this organization, and one we should try to emphasize in the future, the drainage of the farm. We are just as interested in draining the small farm as we are in draining the large areas. It takes legal machinery to handle a large proposition. In some districts we have as many as seven hundred, eight hundred, or a thousand farmers to bring together and get their coöperation in order to bring about the successful completion of some large, comprehensive drainage plan; but this large drainage plan leads only to the small drainage plan. After we have provided the outlets and ways to take off the water the next thing is to get the water into these canals or means of being carried away. We talked yesterday of tiled drainage and the demonstration we had was very good and was very much appreciated by this organization.

This organization has seen practically all classes of drainage work in operation—in the Dismal Swamp of Virginia, in the Piedmont section of North Carolina, and we know that this character of work can be done. We hope next year to view some other class of drainage work.

Now the most important new factor of those I have enumerated is the settlement of our lands. This, I believe, is beginning to be solved. When the swamp lands of North Carolina were first put on the market, it took years of most painstaking effort to make any sales whatever. Now, where you formerly found the sections knee-deep in water, you find thousands of acres of corn growing in one field. Farmers from the middle west are settling on the lands and making them productive. This Association will in the future have to coöperate in letting the virtues of North Carolina lowlands be heralded abroad, so that those outside of the State may know what we have to offer.

A few weeks ago I had the pleasure of addressing a small group of land-buyers from Illinois, who were coming down to look at swamp lands in North Carolina which were being offered for sale. These men—most of them—were ready to buy; they had the cash to pay for the farms, although long term payment was offered. But they knew what they wanted, what characteristics of the soil were required for the successful raising of corn, and what were

required for the raising of other crops. They were not interested in raising truck, cotton, or tobacco, but in raising the crops with which they were thoroughly familiar, and they wanted to know when they went on a piece of land what it had to offer them in the way of return for the work and money they would expend on it.

This desire for knowledge on the part of land-buyers has caused this particular development company to have an experiment farm installed under the charge of an expert, so that if a man wished information in regard to a certain soil he could take samples of that soil, have it analyzed, and find in what particular characteristics that soil was lacking, and what treatment that soil would need to be most productive for the particular crop he wished to raise. This service was furnished free by the development company through the best experts they could get for the prospective purchaser. This is just one phase of work they are doing.

We all want to know how we are going to dispose of our lands when they are drained in large lots. In the drainage districts similar to those between the Piedmont and the low flat areas in the eastern section of the state the matter of selling is not a problem. Most are long, narrow areas, where the ownership of the land is held by a great many people, some owning from ten to five hundred acres, but where the drainage work is being done by each individual farmer for his own good and not by a development company. This applies to sixty to seventy per cent of the drainage districts of North Carolina, but in area the percentage is not so high. The expense of draining these long, narrow districts is greater, but as soon as the land is drained the farmer has added directly to his holdings that much land. He knows how good it is, and can profit by what these larger companies that are making a specialty of it have found out in regard to the treatment of swamp land.

We hope by the next Convention to have data and information for the use of the Convention and its delegates as to the treatment of the swamp lands and as to what crops they are best adapted to.

I think we are just beginning the great forward movement in drainage in North Carolina. As soon as the present difficulties are overcome there will be more drainage work done in North Carolina than we have done in the past six years. Almost everyone interested in drainage work now has in contemplation more work than has ever heretofore been done. The interest manifested in this is growing. While our attendance is not as large as we would like, those who are present came solely for work. We come here to discuss points of difficulty with which we have met, and I hope that this Association may continue to be able to solve in a measure the problems arising as they are presented.

Let us keep our organization strong; let us be eager to show the benefits that will accrue to the state through our efforts; let us continue to make the North Carolina Drainage Association a leading and ever new factor in the progress and development of our state.

DISCUSSION.

Mr. Mengel: I want to emphasize one point in regard to the Drainage Association in the future in relation to these new development companies. I approve the idea of giving people exact knowledge of what they are coming into before they come down. I think the Association, as an Association,

should offer support in the way of publishing and distributing literature and recommend to anybody desiring land that North Carolina is the place to come.

Mr. Brown: I want to say one word in commendation of the plan referred to. I know something about that myself. In bringing to North Carolina farmers from the north and west—here is a caution. Do not bring Europeans unless they come from north of the English Channel or Baltic Sea.

Mr. Brett: The development companies in North Carolina are new factors in drainage work. The individual landowner that coöperates to form a drainage district is the North Carolinian who is interested in developing his own holdings, but if it is good for him the investor or promoter will say—why would it not be a good thing for me to buy five or ten thousand acres, develop it and sell it. I look askance at some of these propositions because there have been colossal frauds put on the American people in selling what are supposed to be drained lands. When I first became associated with some of these land companies I was a little bit critical of their methods until I found out they went on the basis that unless it was first-class we do not want to be associated with it, because unless the purchaser can buy our land and make a living on it, we won't make any progress. That one thing has actuated the methods of every development company in North Carolina. They sell on easy terms—the farmer can come in for small cash payments, and they assist him in every way to make a success of the undertaking. They deserve our highest praise and warmest coöperation.

Reports of Committees

COMMITTEE ON RESOLUTIONS.

The North Carolina Drainage Association in this its Seventh Annual Convention may well be pleased with the progress of the work done and the good results therefrom throughout the middle and eastern sections of the state. These results are inspiring greater activity as they become better known and the work of reclaiming our swamp lands has already reached a stage of certainty as to the profitableness in other respects than for agricultural purposes.

The drainage and incident reclamation and development of our swamp lands brings many phases of betterment to the community and to the state, by way of producing more and better assets in the form of products raised, which necessitates the movement for good roads by which to market such products. Good roads will lead to good schools, which will promote better citizenship, modern farming, increased values, and the substance of living at home.

Resolved, That we urge the General Assembly to carefully consider what we have already done for the advancement of this work by investigating the good that has been accomplished in the work of agricultural development and incidentally increased revenues and values of farm lands, after which we feel they can better see the needs for the coöperation of the whole state in this work.

Resolved, That this Association urge the committee and other officers of all drainage districts, which have been organized and completed, to attend

the annual Association meetings and make reports of their districts for the benefit of the Association, we believing that those having experienced the benefits are more capable of imparting this information and that we believe the same would be a great help towards the furtherance of the cause of drainage.

Resolved, That we urge the General Assembly to give careful attention to the necessity for legislation which will protect our drained swamp lands from fires and our canals from damage caused by stock running at large. We commend to the consideration of our representatives at Raleigh the fact that our drained swamp land and overflowed areas are of great value and that their protection is a matter of public welfare.

Resolved, That this Association coöperate in any state- or nation-wide movement to encourage immigration to this state. We realize that one of the most important factors in the success of the drainage work is the bringing in of a desirable class of settlers who will live on their lands and cultivate them. We should welcome and aid the newcomer, and he will make us a good citizen and aid us in realizing the possibility of ours.

Resolved, That we commend to the General Assembly the State Geological and Economic Survey as worthy of most generous support, representing as it does most important activities that are constructive forces in the upbuilding of our state.

Resolved, That we extend our thanks to the United States Department of Agriculture, to the office of Experiment Stations and to the Board of Drainage Investigations for the aid they have given in solving our drainage problems, and in placing in our state an able and efficient drainage engineer to advise our people and help us with our work.

Resolved, That we extend the thanks of this Association to the State Department of Agriculture and to its various officials for the work done by demonstration farms and soil surveys and in placing an engineer in the field to aid in drainage work.

Resolved, That this Association extend to the officials of our railroads thanks for their interest in our work, and particularly to the Norfolk Southern for the address of Mr. B. E. Rice, and his participation in the Convention.

Resolved, That the Association extend to Congressman John H. Small thanks for his untiring interest in our work and for the inspiring address delivered before this Convention.

Resolved, That the Association express its appreciation to the John L. Roper Lumber Company for their interest in our meetings, and for the instructive paper presented by their representative, Mr. C. W. Mengel.

Resolved, That we extend thanks to the press of the City of Wilson and to other papers in the state for giving publicity to this Convention and its work.

Resolved, That we extend thanks to Mr. J. C. Cowley for his interesting and helpful demonstration of tile drainage on his farm, and to urge him to attend all of our annual meetings in the interest of tile drainage.

Resolved, That this Association extend thanks to the City of Wilson and its officials for the hearty welcome and support of the Convention; to the Commonwealth Club and the Chamber of Commerce, and to the Entertainment Committee and citizens of Wilson and the County, for their careful at-

attention and many courtesies extended all our delegates; to the City for the use of the City Hall, and to the management of the Opera House for its use as meeting places for the Convention.

W. K. ALLEN, *Chairman*.
JOHN H. SMALL.
J. G. MILLS.
H. M. LYNDE.
P. H. JOHNSON.
M. E. SHERWIN.
J. C. STANTON.
C. A. FARNELL.

The report of the committee was accepted and the resolutions were unanimously adopted by the Convention, as introduced.

The Membership Committee made its report as follows:

REPORT OF MEMBERSHIP COMMITTEE.

With the future of the large reclamations assured, it is important that more farmers become active members of the Association. To that end your committee recommends that this Association invite the attention of the officials of the Farmers' Union, the Forces of Farm Demonstration Work, the State Department of Agriculture, and especially those engaged in institute work, because if the individual farmer is not interested he will not apply improved methods of farm drainage and thereby reap the benefits to which he is entitled from the organized districts in his own communities.

We feel that as good drainage is indispensable to good road construction and maintenance, that this Association invite every highway engineer in the state to become identified with the interests and activities of this Association.

There are fifty-nine delegates registered, representing sixteen counties in the state, and two delegates from Virginia.

M. E. CHAPPEL, *Chairman*.
E. E. SCHOOLEY.
ZENO MOORE.
H. D. BROWN.

The report of the committee was accepted and adopted as read.

Counties Represented at Convention

The following counties were represented at the Convention: Beaufort, Edgecombe, Gaston, Greene, Guilford, Hyde, Lenoir, Nash, New Hanover, Orange, Pender, Robeson, Wake, Washington, Wayne, and Wilson.

Mr. Brett, chairman of the Legislative Committee, made the following report:

REPORT OF LEGISLATIVE COMMITTEE.

The undersigned, your Legislative Committee, beg to offer the following as their report:

Since the Charlotte meeting of the Drainage Association your committee has discussed at various times the matter of amendments to the law and has

by correspondence gone into this matter with several members of the Association. We have in our possession a considerable amount of material which we have collected relative to proposed amendments. Realizing that in order to make our work effective we must take time and give careful consideration to the amendments proposed and to the relation of the general law as it now stands, we recommend to the Association that a Legislative Committee be appointed by the Association to which we will give the data collected by us and with which we shall be pleased to coöperate in every way. We recommend that each committee, when appointed, set aside the necessary time and meet at some central point, there to go over thoroughly all proposed changes to the drainage law, and to put the same in shape to be introduced at the next meeting of the General Assembly of North Carolina.

We respectfully recommend to the Association the necessity for the committee so appointed to give of its time a sufficient amount to see that the amendments proposed have careful consideration by the General Assembly and to have a sufficient number of its membership present in Raleigh to explain and defend the amendments desired and to see that, if possible, the recommendations of the Association are carried out without change.

We urge on every member of the North Carolina Drainage Association that amendments desired be considered and that members interested in changes of the law put their desires in writing and address the same to the Chairman of the Legislative Committee. In this written form the committee will have all facts before it.

Respectfully submitted,

LAWRENCE BRETT, *Chairman.*

JOHN H. SMALL.

JOHN P. KERR.

M. F. H. GOUVERNEUR.

E. B. CROWELL.

G. B. SELLARS.

M. W. THOMPSON.

J. L. BECTON.

DISCUSSION

Mr. Brett: We have fifteen pages of typewritten matter submitted in regard to proposed changes. We cannot say we will recommend this or that until we have all in hand that we want to consider, because we do not want to make any mistake and recommend something that will put our law in such a shape that it won't work; but we want everybody who has amendments to be taken up at this meeting to put them in written form and report to the committee appointed today and we will hand over to the committee the data we have, so that when this committee meets prior to the Legislature and re-drafts the drainage law, they will have all the information in hand with which to work. We cannot say we recommend this today, until we know if something better is suggested, because we want to serve all parties in connection with this amendment.

The report of the Legislative Committee was adopted as read.

The report of the Committee on Nominations and Next Meeting Place was read by Mr. C. W. Mengel, in the absence of the Chairman of the Committee, Mr. J. A. Wilkinson.

REPORT OF THE COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE.

We, the Committee on Nomination of Officers and Next Meeting Place, beg leave to submit our report, as follows:

Place for next meeting—Belhaven.

For President—Mr. Lawrence Brett, Wilson.

For Secretary-Treasurer—Dr. Joseph Hyde Pratt, Chapel Hill.

For First Vice-President—Mr. P. H. Johnson, Pantego.

For Second Vice-Presidents the following:

Anson County—E. A. Barrett, Polkton.
 Beaufort County—P. H. Johnson, Pantego.
 Bertie County—Francis D. Winston, Windsor.
 Bladen County—O. L. Clark, Clarkton.
 Brunswick County—Jackson Johnson, Town Creek.
 Cabarrus County—J. Lee Crowell, Concord.
 Chowan County—W. S. Privott, Edenton.
 Columbus County—Joseph A. Brown, Chadbourne.
 Cumberland County—W. A. Beard, Fayetteville.
 Cleveland County—G. F. Hambright, Kings Mountain.
 Gates County—A. T. Godwin, Gatesville.
 Guilford County—M. W. Thompson, Greensboro.
 Halifax County—John L. Patterson, Roanoke Rapids.
 Harnett County—A. J. Dunn.
 Hertford County—R. C. Bridger, Winton.
 Hyde County—Greeley Brinn.
 Iredell County—E. S. Milsaps, Statesville.
 Jones County—J. H. Bell, Pollocksville.
 Lincoln County—W. A. Graham, Lincolnton.
 Mecklenburg County—W. S. Pharr, Charlotte.
 New Hanover County—B. F. Keith, Wilmington.
 Onslow County—E. M. Koonce, Jacksonville.
 Pender County—J. A. Ziblin.
 Pitt County—Alston Grimes, Grimesland.
 Robeson County—J. B. Sellers, Maxton.
 Rockingham County—R. P. Richardson, Reidsville.
 Rowan County—C. M. Miller, Salisbury.
 Wake County—J. G. Mills, Wake Forest.
 Wayne County—W. W. Peirce, Goldsboro.
 Washington County—Van B. Martin, Plymouth.

We also ask that the President appoint second vice-presidents in counties not represented on the list, as he may see fit.

Respectfully submitted,

J. A. WILKINSON, *Chairman.*

C. W. MENGEL.

F. R. BAKER.

W. W. PEIRCE.

R. M. SQUIRES.

D. B. McNEILL.

T. W. CHAMBLISS.

The report was accepted and upon motion the Secretary was instructed to cast a ballot for the officials as recommended by the committee. These were declared unanimously elected.

Belhaven was unanimously voted the next meeting place.

The new president was escorted to the chair by Mr. W. K. Allen and Mr. P. H. Johnson, and addressed the Convention in the following words:

It is needless to say that I consider this a great honor. I have been interested in the work of this Association from the beginning. I have watched its growth with a great deal of interest and have done, so far as I was able, everything possible to further drainage work in North Carolina. As the new President of this Association I shall try to do even more than I have tried to do in the past, and to work and to give my time to the interests of this Association wherever possible.

I appreciate very much the honor you have given me, coming as it did very unexpectedly, but I will do the best I can to further the work of this organization.

Dr. Pratt called attention to the model prepared by Mr. F. R. Baker, illustrating tile drainage and charts illustrating different phases of tile drainage which were exhibited in the Opera House. He also called attention to the points of interest in Wilson, listed on the last page of the program, and to "Peg O' My Heart," which would be played in the local opera house the evening of November the nineteenth.

DISCUSSION.

Mr. Small: I would like to present to the Association this thought, in the form of a query: Why can't we have four hundred or five hundred delegates in attendance at the next meeting of the Association? We ought to have them. I am sure that every delegate who has attended this session, as during every past session, would say that he has been benefited by it. I am sure that they have been benefited and have become more or less enthusiastic over the improvements that this drainage problem has been emphasizing. If that is true we can do a public benefit by extending that individual benefit to a number of others. If I may make a suggestion I would suggest that beginning two months before the next meeting of the Association that the President of the Association adopt this plan: By looking over the printed proceedings of the past meetings he could get the name and address of every delegate who has attended at any time, and a letter to each of them, together with a few others in various counties whose names might be suggested, asking them to suggest the name of every citizen in their county who might be induced to attend the meeting. Then, having obtained a complete list of perhaps one thousand or fifteen hundred names, to prepare a signed letter to be sent to each one of those names, setting forth as briefly and attractively as possible, in not more than one page, the purposes of this Association, its claims to public support and confidence, and asking the question as pointedly as can be done without offense—whether he can attend. Enclose a stamped envelope and ask him to write whether or not he can attend, and he will feel under some compunction to reply. I know it involves a good deal of trouble,

but if it will bring to our next meeting four hundred live and purposeful delegates it will be like the traveling man from Baltimore who made a trip to North Carolina and had to pay three dollars for a quart of whiskey. But he said it was worth the cost; so this effort will be worth all it costs. I suggest that the President do this because the Secretary is pretty well worked, not only with this Association but with the North Carolina Highway Association and several other activities of the state, and also because he has been so closely identified with this Association that a new name might be a little more compelling, and I believe instead of the delegates to the next meeting being confined to the area near the place of meeting, that we can have them scattered through the state more largely and, in addition, increase our attendance certainly one hundred, if not two hundred. We are all subject to be influenced by our environment, and it won't do to let this attendance get too small, for if we do some will say—nobody else is taking interest, why should I? If we can get three hundred or four hundred at the next meeting we will have a new start, and while my friend, Mr. Johnson, can talk for himself, I want to say that Belhaven is a good place to go to. It is a nice town—has a fine public school building and fine public schools, a live Board of Trade and Secretary, and is the most delightful place on the water in North Carolina. The point I want to make is to have four hundred delegates next time and resolve to help the President. The President does not mind work, and I have always found that the more work a man does the more he can do and does. After an experience of fifty years I am prepared to say that the only men who really perform their promises and do all the work allotted to them systematically and on time are the men who have plenty to do all the time.

Mr. Johnson: I would like to suggest just one query that should appear in that letter to be sent to the delegates: "Have you ever been to Belhaven? If not, why not?" And I want to say to you that we will promise every one who attends that Convention that we will show you actual development, not only of canals that have been cut, but we will show you land being cleared in all stages, beginning where the first trees are being cut down and ending in a bumper corn crop. In addition to that we will take you down and show you the Mattamuskeet Lake project and we will show you that we have ample accommodation to take care of the four hundred delegates, and more if they come, and we shall be greatly disappointed if we have less than four hundred present.

To the President I want to say that the Board of Trade will be glad to coöperate with him in any scheme he may devise to help get that crowd there.

**Registered Delegates to the Annual Convention of the North Carolina
Drainage Association, Held at Wilson, November 18-19, 1914**

Allen, W. K.	Wilmington, N. C.
Baker, F. R.	Raleigh, N. C.
Barnes, K. W.	Lucama, N. C.
Becton, J. L.	Wilmington, N. C.
Berry, Miss H. M.	Chapel Hill, N. C.
Boddie, Nick B.	Nashville, N. C.
Brett, Lawrence	Wilson, N. C.
Brown, F. A.	Wilson, N. C.
Brown, H. D.	Wilson, N. C.
Cardwell, Guy A.	Washington, N. C.
Chambliss, T. W.	Wilson, N. C.
Chappel, M. E.	Swan Quarter, N. C.
Clarke, J. L.	Richmond, Va.
Cooper, C. W.	Wilson, N. C.
Cowley, H.	Creamsdales, Wilson, N. C.
Cowley, J. C.	Wilson, N. C.
Cox, J. W.	Elm City, N. C.
Crittenden, H. T.	Box 444, Wilson, N. C.
Davis, W. J.	Wilson, N. C.
Deans, A. B.	Wilson, N. C.
Freeman, R. W.	Wilson, N. C.
Frizzelle, J. T.	Greene County.
Gass, A. S.	Wilson, N. C.
Gay, S. S.	Nashville, N. C.
Gold, P. D.	Wilson, N. C.
Graves, M. W.	Wilson, N. C.
Hodges, C. W.	Kinston, N. C.
Johnson, P. H.	Pantego, N. C.
Keith, B. F.	Keith, N. C.
Land, Charles A.	Borden Brick and Tile Co., Goldsboro, N. C.
Lane, H. B.	Wilson, N. C.
Lucas, Silas	Wilson, N. C.
Lynde, H. M.	Raleigh, N. C.
McArn, Miss Nan	Chapel Hill, N. C.
McNeill, D. B.	Lumberton, N. C.
Mengel, C. W.	Winona, N. C.
Mewborn, L. J. H.	Snow Hill, N. C.
Milk, J. G.	Wake Forest, N. C.
Moore, Zeno	Whitaker, N. C.
Ormond, W. W.	Greene County.
Pace, T. S.	Wilson, N. C.
Patrick, D. W.	Greene County.
Peirce, W. W.	Goldsboro, N. C.
Poe, S. E.	Mt. Gilead, N. C.
Pratt, Joseph Hyde	Chapel Hill, N. C.
Rice, B. E.	Norfolk Southern Railroad, Norfolk, Va.
Roney, J. G.	Wilson, N. C.

Schooley, E. E.....	Belhaven, N. C.
Sherwin, M. E.....	West Raleigh, N. C.
Small, John H.....	Washington, N. C.
Squires, R. M.....	Wake Forest, N. C.
Stanton, J. C.....	Stantonsburg, N. C.
Strickland, N. L.....	Nashville, N. C.
Thompson, H. E.....	Stantonsburg, N. C.
Thompson, M. W.....	Greensboro, N. C.
Wickham, W. J.....	Route No. 4, Wilson, N. C.
Wilkinson, J. A.....	Belhaven, N. C.
Woodard, Walter F.....	Wilson, N. C.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
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21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
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23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*
24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 plates, 5 figs. *Postage 15 cents.*

ECONOMIC PAPERS.

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-time Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Loz Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of western North Carolina are described, giving distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; The new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, Forester, 1915. 8°, pp. *Postage cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

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Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

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Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey

for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 190 pp. *Postage 14 cents.*

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY
JAMES H. HAYES, CHIEF

ECONOMIC PAPER No. 11

ORGANIZATION
OF
CO-OPERATIVE FOREST-FIRE
PROTECTIVE AREAS
IN
NORTH CAROLINA

PROCEEDINGS OF THE SPECIAL CONFERENCE ON
FOREST FIRE PROTECTION

CONFERENCE ON FORESTRY AND NATURE STUDY

WESTGATE, N. C., JULY 4, 1911.

J. H. HAYES, Chief, Editor.



Published by the
J. H. HAYES, Chief, Editor.

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 42

ORGANIZATION
OF
CO-OPERATIVE FOREST-FIRE
PROTECTIVE AREAS
IN
NORTH CAROLINA

BEING THE
PROCEEDINGS OF THE SPECIAL CONFERENCE ON
FOREST FIRE PROTECTION

HELD AS PART OF THE
CONFERENCE ON FORESTRY AND NATURE STUDY

MONTREAT, N. C., JULY 8, 1915

PREPARED BY

J. S. HOLMES, State Forester



RALEIGH
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1915

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LETTER OF TRANSMITTAL.

CHAPEL HILL, N. C., September 1, 1915.

To His Excellency, HONORABLE LOCKE CRAIG,
Governor of North Carolina.

SIR:—On account of the importance of the protection of our forests from fire, I herewith submit for publication, as Economic Paper 42, a report on the Proceedings of a Special Conference that was held at Montreat, North Carolina, July 8, which took up the organization of coöperative forest-fire protective areas in North Carolina. As a result of this conference, several of these areas or districts have already been established.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

PREFACE.

The enactment of the new forest fire law by the General Assembly of 1915 made possible coöperation between the Federal Government and the State Geological Board in forest fire protection. An agreement was thereupon entered into between the Secretary of Agriculture and the State Geologist whereby a sum not to exceed \$2,000 per year might be spent in North Carolina by the Federal Government, under the Weeks Law, for the employment of patrolmen and lookout watchmen in a definite scheme of fire protection organized and controlled by the State forestry authorities.

The Federal Government, however, has always required a certain amount of coöperation from the local landowners as well as from the State authorities before spending money to assist in this work. In order, therefore, to get the different interests together, and to arrive at some understanding which might result in getting this most important work started in North Carolina, the State Forester called a special conference on this subject to meet at Montreat, N. C., on the second afternoon of the Conference on Forestry and Nature Study. Western North Carolina lumbermen and other landowners, manufacturers using timber, railroad companies operating in that region, cities and towns, as well as interested associations, were invited and urged to send representatives. A good number accepted, as will be seen from the list of those present. The Federal Government's cordial coöperation in the program was of the greatest assistance.

The following account of the proceedings of the Special Conference is published for the information of those landowners who did not attend, yet who may be interested in coöperative forest fire protection, which is recognized as the most effective means of reducing the fire loss.

JOSEPH HYDE PRATT,
State Geologist.

LIST OF REPRESENTATIVES IN ATTENDANCE.

R. F. BREWER, Land and Industrial Agent, C. C. & O.
 Railway ----- Johnson City, Tenn.

B. E. RICE, Industrial Agent, Norfolk Southern Rail-
 way and John L. Roper Lumber Company----- Norfolk, Va.

F. S. COLLINS, Southern Railway Company----- Asheville, N. C.

A. S. GUERARD, Southern Railway Company----- Asheville, N. C.

J. L. HATCH, Southern Railway Company----- Salisbury, N. C.

F. STIKELEATHER, City Water Department----- Asheville, N. C.

D. HIDDEN RAMSEY, City Water Department----- Asheville, N. C.

G. S. POWELL, Appalachian Park Association----- Asheville, N. C.

S. P. RAVENEL, Appalachian Park Association----- Biltmore, N. C.

T. B. FINLEY, Timberland Owner----- North Wilkesboro, N. C.

F. L. WINCHESTER, Champion Fiber Company----- Canton, N. C.

G. L. WOOD, Montvale Lumber Company, R. E. Wood
 Lumber Company ----- Baltimore, Md.

B. H. STONE, Pfister & Vogel Land Company----- Blairsville, Ga.

F. L. BLYTHE, Eastern Cherokee Indians----- Cherokee, N. C.

F. M. PERLEY, Perley & Crockett Lumber Company---- Black Mountain, N. C.

J. W. CHURCH, Forestry Club----- Tryon, N. C.

W. T. LINDSEY, Forestry Club----- Tryon, N. C.

GEORGE B. COBB, Forestry Club----- Tryon, N. C.

B. C. A. VON KAHLDEN, Forestry Club----- Tryon, N. C.

WILLIAM M. HALL, U. S. Forest Service----- Washington, D. C.

J. G. PETERS, U. S. Forest Service----- Washington, D. C.

W. W. ASHE, U. S. Forest Service----- Washington, D. C.

L. L. BISHOP, U. S. Forest Service----- Marion, N. C.

J. J. FRITZ, U. S. Forest Service----- Highlands, N. C.

R. F. HEMMINGWAY, U. S. Forest Service----- Andrews, N. C.

VERNE RHOADES, U. S. Forest Service----- Asheville, N. C.

E. P. BUSHNELL, U. S. Forest Service----- Asheville, N. C.

JOHN RIIS ----- Winston-Salem, N. C.

JOSEPH HYDE PRATT, State Geologist----- Chapel Hill, N. C.

J. S. HOLMES, State Forester----- Chapel Hill, N. C.

ORGANIZATION OF COÖPERATIVE FOREST-FIRE PROTECTIVE AREAS IN NORTH CAROLINA.

CONFERENCE HELD AT MONTREAT, N. C.

Thursday, July 8, 1915, 3 P. M.

JOSEPH HYDE PRATT, Chairman.

PROCEEDINGS.

DR. PRATT: It may be well at the beginning of this conference to state briefly what the North Carolina Forest Fire Law really means to the State. It is the result of an educational campaign carried on by the North Carolina Forestry Association, the State Geological and Economic Survey, the various women's clubs throughout the State, certain township clubs, and others interested in forestry work.

The act authorizes the Geological Board to take up the proposition, or the problem, of protecting the forests from fire. While there is no direct appropriation made under this particular act, the Geological Board has an appropriation for forestry purposes, and from this appropriation we have been able to set aside a certain amount that can be used under this act; that is, used in connection with the carrying out of the purposes of this act.

Under this act the Forester appointed by the Geological Board (in this case, Mr. Holmes) is made State Forester and *ex officio* State Forest Warden. The board is also given authority under the act to appoint forest wardens who will have the same rights and powers as deputy sheriffs; in other words, they can make arrests without a warrant in carrying out the laws that have been passed by the General Assembly relating to forest fires. The State also has the right to require the services of men and teams to assist in fighting any fire that may be started. The act is liberal and broad in the power that it gives to the State Forester in connection with this work.

The wardens, patrolmen, and others must be paid for their services. The act regulates their compensation, but makes no appropriation for this purpose. In order to carry on the work and protect certain areas of our forests from fire, funds must be raised in some way.

Through the passage of this Forestry Act we are able to coöperate with the Federal Government under the Weeks Law, which we have not been

able to do up to the present time because we have had no State forest fire law. We have had laws relating to forest fires, about starting fires and extinguishing fires, but we have had no machinery whatever that could in any way enforce these laws. The new act gives the machinery necessary to enforce the laws that have been passed and that may be passed, provided we can raise sufficient revenue to pay the men that act as wardens and patrolmen under the authority of the Geological Board.

An agreement has been entered into between the Geological Board and the United States Department of Agriculture by which, under the Weeks Law, we will obtain from the Federal Government \$2,000 that can be expended in the protection of forests from fire; this amount being supplemented by \$2,000 from the Geological Board, which is to be spent in paying salary and expenses of the State Forester; in posting fire-warning signs, in educational work, and preparing publications relating to forest fires. Now, we want to supplement this amount, if possible, by contributions from individuals, from corporations, from railroads, and others who are interested in the protection of our forests. The chief reason for this conference today is to obtain your coöperation in this work of protecting our forests from fire.

I might as well state, at the outset, that there is no use taking what money we can raise—for it will only be a comparatively small amount—and trying to spread it out in a thin layer all over the forested areas of North Carolina, for if we do *we will not get results*. It seems to me, as we have considered the situation, that the best plan for us to follow is to take certain definite areas or districts to which a sufficient appropriation can be made that will insure putting into effect adequate measures for protecting these areas from fire.

Of course, the work will be done under the direct supervision of the State officials, but with the approval of the United States Forest Service. It means that the actual plan of work will be the same as has been inaugurated by the Forest Service in other sections of the country and in connection with the protection of their own lands in this State.

We have not as yet selected the areas to be protected; these recommendations will be by the Geological Board, and will have to be approved by the Forest Service. As yet, we have not made any recommendations as to what areas we shall start with in carrying out this system of protection of our forests, with the exception of the Mount Mitchell area, whose purchase was authorized by the General Assembly of 1915 and which will be a State forest. Outside of this, nothing has been decided upon, and as you can see, from the calling of this conference, it will depend largely on the support and coöperation that we can get from those interested in certain forested districts.

I think I am voicing the opinion of others in this State, of the members of the Geological Board (who considered this question at their semiannual meeting last week), as well as of members of the Forest Service, when I say that we wish, as far as possible, to obtain a few large areas to protect rather than a larger number of small areas. In other words, what we have to do and what we must do during the coming two years is to make such a showing in carrying out the provisions of the Forest Fire Act that when we go before the General Assembly in 1917 there will be no question whatever but that we will get an adequate appropriation for the protection of the forests of North Carolina. I believe it can and will be done. I see no reason why we cannot take certain areas and prove indisputably and definitely that the law can be made effective in the protection of the forests.

This afternoon I hope we can have an open discussion of the operation of the State Forest Fire Act, and also statements as to what you think can be done by you as representatives of certain sections in coöperating with us in carrying on this work.

MR. PETERS: Gentlemen, the part of the Weeks Law which relates to coöperation with States in forest-fire protection provides, first, that the protection must be confined to the watersheds of navigable streams; second, that the State must establish by law a system of fire protection; and, third, that the Federal Government cannot expend more money in any year than the State itself expends. The present total yearly appropriation for this coöperation is \$100,000.

North Carolina, through the law which Dr. Pratt has just explained, has met all three conditions. The State has requested coöperation, and the Government has agreed to allot to the State \$2,000. I am sorry that it cannot be more, but we are duplicating the State's fund, and that is as much as we can do. State Forester Holmes has been appointed a collaborator in the Forest Service and thereby given authority to employ men to do patrol or lookout work. Practically all of the Federal fund will be used for the hire of these men.

The State will offset the Federal expenditure by the portion of the State Forester's salary and expenses and the administration charges of his office which are properly chargeable to fire protection, together with such printing charges as may be incurred for publicity work in fire protection, that is, posters, fire notices like those Mr. Holmes has gotten out, and such notices as you see tacked up around this room, which with few exceptions are used by the Federal Service.

Unfortunately, the State has no funds for hiring patrolmen or lookout watchmen; so what we propose to do is to place Federal men of this

character on areas where the private owners themselves are taking or are willing to take an active interest. What I mean by active interest is actual coöperation in the form of hire of patrolmen, establishment of lookout stations, or other lines of work which show an expenditure of funds. Of course, we would want the owners to agree to pay the cost of any fire-fighting expense which may result from fires that start on their lands. Naturally, we do not want to place our men on areas where, if a fire occurs, they are unable to put it out for lack of funds. You can readily see the impracticability of that.

The work should be organized so that the area to be protected will be divided into patrol districts. I suppose it would keep one man fairly busy to patrol 10,000 acres in this region and do it thoroughly. This area he should subdivide into smaller districts, and appoint in each a man to act as foreman in time of a fire, whom he could rely on to get a crowd of men together and endeavor to extinguish the fire. Fires are reported by various means. The best we know of at the present time is the telephone. One of the most practical ways of securing quick notification here is for timber owners to extend their telephone systems up to lookout stations on prominent mountains. Federal watchmen might be placed there, and, when they discover fires, they can notify some one in the valley beneath. Thus considerable time would be saved. It all boils down to this: that in order to get effective protection you ought to be prepared, and you ought to plan your methods in advance. If you wait to act until the fire has started, somebody will get stampeded and a lot of mistakes will be made.

I think the best means that private timber owners can adopt to meet the danger from fire which is common to all in this locality is to organize a timber protective association. A number of such associations have been formed, and I wish to present for your consideration the numerous reasons for organizing one. We hear of coöperative societies being formed in various parts of the country to reduce the high cost of living. Why not organize a coöperative society or association in North Carolina to reduce the high cost of forest fires, that is, the large damage from forest fires and the cost of protection against them? This is not a new idea, and it is significant that wherever put into effect it has worked out successfully, and not one of the organizations has been discontinued.

Timber owners' protective associations were first established on a large scale in Idaho in 1906, and since then the movement has spread through the northern tier of States to the Pacific and Atlantic coasts, and is gradually reaching into the Southern States. Some forty associations of this character have been organized in the States of California, Oregon,

Washington, Idaho, Montana, Michigan, New Hampshire, Maine, Pennsylvania, West Virginia, and Kentucky. I think you will make no mistake by forming an association in North Carolina.

Thousands of acres in this State are covered with coniferous forests similar to those of the Northern States and West Virginia, and subject, as all of you know, to fires that sweep up into the tree-tops and destroy entire stands. In your hardwood forests the damage to merchantable timber is confined chiefly to the butts of the trees, which repeated fires leave scarred and hollow, thus making them much more liable to attacks from insects and fungi.

The loss from fire in this State has been enormous. Based on the statistics collected by your State Forester, which, I might add, are among the best available for any State, the average number of fires reported yearly for the period 1909 to 1913 is about 650, and the area burned over about 400,000 acres with a money loss of approximately \$450,000. But these are only present losses, those which are tangible. In addition, there are great future losses, including the destruction of small trees upon which depends the permanency of the lumber industry in this State; the deterioration of the soil and the forest; the crowding out of valuable timber trees by inferior ones; damage to water resources; interruption of business; and depreciation of property. Such losses can best be reduced by the organized joint effort of all interests concerned. As a means toward this end, I strongly urge you, gentlemen, to form a protective association.

As a rule, associations of this kind are organized as follows: Each has its by-laws and executive officers; a board of directors determines its general policies; a forester or chief fire warden supervises the field work. All timber owners are invited to join, from the large corporation to the owner of, say, 100 acres. Funds are raised by assessment on an acreage basis, from less than 1 cent an acre up. Usually each member, whether his acreage is large or small, has equal vote in association affairs. Patrolmen and other members of the field force are given police powers and authority to summon help to fight fires through appointment as township, county, or State fire wardens. I have here the constitutions and by-laws of some of these associations for your information.

The Coeur d'Alene Timber Protective Association in northern Idaho was the first of its kind to be organized, and its constitution has been the basis for practically all the associations which have followed. It is the one the West Virginia Association followed. I was fortunate enough to be on hand when that association was organized, and the owners adopted this constitution with the exceptions that the assessment was limited to

1 cent per acre per year and each member was entitled to one vote for every thousand acres, each being entitled to at least one vote, no matter how small his property. One of the Oregon associations requires a member to stand the expense of fighting a fire which occurs on his land, for the first 48 hours, before he can draw on the association fund.

So beneficial have been the results of coöperative effort that practically no member has withdrawn from an association. On the contrary, members are willing to contribute more liberally. At 1 cent an acre, a member would pay \$200 on 20,000 acres. Without organized protection he might spend that much fighting a single fire, not to mention his loss in timber burned and in shutting down his camps and mills. Under the association plan he not only has fewer fires and gets off cheaper, but escapes the worry also. I believe that through coöperative patrol and fire fighting the loss can be greatly reduced in your forests.

The cost would be small, considering the value of the property insured. I will give you some idea of the costs where associations have been formed. The Central West Virginia Fire Protective Association, representing 700,000 acres, began active operations in the fall of 1914 and expended during that period approximately \$2,837, as follows:

Field manager, or Chief Fire Warden, salary, 6 months	
@ \$125 -----	\$ 750.00
Expenses -----	437.59
Patrolmen's salaries and expenses -----	1,184.56
Printing, stationery, posters -----	61.68
Publicity work -----	66.00
Postage -----	23.24
Telephone construction -----	306.31
Miscellaneous -----	7.53
Total -----	\$2,836.91

Concerning the reduction of the usual fire loss in the territory of this Association, the report says:

"In discussing the work done, it is necessary to mention that the system of protection was given as severe a test during the past months of September, October, and November as could well be imagined. It happened that this fall has been the driest and most dangerous for fires of any that has been known in the State, and large destruction of timber has been reported outside of those sections under protection. In Monroe County, just south of the area in which we are interested, one fire is said to have covered twenty-five thousand (25,000) acres, with considerable loss; and in all of the counties there has been unusually heavy loss, despite the special effort that has been made this year by the State to keep down fire damage. In the Association area we have had forty (40) fires. Our men have fought some fifty-six (56) fires.

including twelve (12) that happened to start on adjoining land and were controlled before they reached us. The forty (40) fires burned over an area of 2,189 acres upon our land. Most of the fires were fought when they were small and stopped before they gained headway sufficient to cause great danger, and most of the fires started in brush or cut-over land and were stopped before they reached good timber. The loss is about two-sevenths of 1 per cent of the area protected. There are no definite records in previous years by which to compare this, but according to trustworthy report there has been an actual and large reduction in the area usually burned over, some placing it as high as 75 per cent. Thus, to reduce the normal area of fire damage in a year when all other regions suffered loss far above the average, should be sufficient proof that the system applied can produce the desired result; and should, in a normal year, result in a still smaller per cent of damage, which we hope to show in 1915."

The New Hampshire Timberland Owners' Association, with approximately 1,000,000 acres, expended in 1913 \$9,767.44, as follows:

Patrol	\$6,194.20
Mountain lookout station	150.57
Telephone account:	
repairs	102.92
exchange and toll expense.....	244.14
District chiefs	610.50
Advertising	68.27
Salary	1,500.00
Office expenses	306.84
Traveling expenses	500.00
	<hr/>
	\$9,767.44

The Coeur d'Alene Timber Protective Association of Idaho, with 440,890 acres, expended in 1913 \$5,756.70, as follows:

Contribution to Western Forestry and Conservation Association	\$ 869.38
Telephone construction and maintenance.....	497.90
Salary of fire warden.....	1,200.00
Office expenses	283.98
Transportation	140.03
Cleaning out old trails.....	397.60
Six saddle horses.....	250.00
Patrolling	1,543.09
Fighting fires	187.07
Miscellaneous expenses	387.65
	<hr/>
	\$5,756.70

Expenses will vary with the seasonal hazard. A skeleton force is maintained during normal seasons, which is increased as the danger becomes greater. Experience has demonstrated that the cost decreases as time goes on, because of increased respect for the fire laws and the addition of new members to the association. As a rule, at the start many timber owners do not join, and those who do have to pay for protecting the other fellow's land in order to protect their own. But gradually the delinquents come in, and so the pro rata is decreased.

The association exists primarily for actual field work, but it adds tremendous strength to the whole protective movement through its ability to educate the public and shape remedial legislation. A patrolman cautioning a logger or a hunter to be careful with fire, or prosecuting an offender, is immensely stronger with a broad, useful organization back of him than he would be as the employee of one timber owner. An association that can show its own liberal expenditure and practical results has an unquestionable right to suggest legislation and request appropriations for State work.

The chief advantages of association over individual effort are that responsibility is centralized, the work is systematized and conducted more efficiently, and the cost is kept at a minimum through lack of duplication of the various activities.

Gentlemen, I earnestly hope that we can all get together and coöperate in this work of fire protection in North Carolina.

I thank you very much.

DR. PRATT: I was very much interested in what Mr. Peters had to say in regard to these coöperative forest fire associations; that is, protective associations. It seems as though we could, here in North Carolina, divide the State into large districts and try to get the lumbermen in the districts to organize and coöperate with each other and the State and Federal governments, and thus get some pretty effective results in the protection of our forests from fires.

There is one point that I want to bring out, which I do not think Mr. Peters spoke of, and that is, if you organize without any relation at all to the State you have little or no authority in regard to the enforcement of any of the laws. In other words, your men may be patrolmen, but really not wardens; they have no legal authority. But if you coöperate with the State, the State Forest Warden, who is the same person as the State Forester, then has the authority to appoint, with the approval of the Geological Board, your wardens and your patrolmen, and they are given the authority authorized in the North Carolina Forest Fire Act.

So in that way the men who are going to be the patrolmen have the authority designated in that act.

There are several landowners in this State who have been protecting their lands and have obtained some pretty good results; their patrolmen have, however, insufficient authority. They have no way of bringing a man to justice without going out and getting some one to issue a warrant for him. If they were forest wardens, under this present act, they could arrest the man at once, and a few arrests, I think, would stop a great deal of the carelessness that now results in so many of our forest fires.

I would like to hear from all of you who are representing lumber companies, railroads, etc., your ideas as to the possibility of doing effective work through Forest Fire Associations in North Carolina.

The Conference is open.

MR. LINDSAY: I represent an organization, the Tryon Forestry Association, a club already organized for this very purpose, *i. e.*, forest protection. Our delegation comes here without authority to pledge any amount of money, and, in fact, without authority to make any pledge, but we delegates take it upon ourselves to pledge that we will fight the fires and pay all the expenses of fighting the fires, and not only that, but we will do all the missionary work possible in awakening the people to the necessity of fighting fires, provided the United States Government and the Geological Board will see fit to place a patrolman in Tryon Township. Tryon Township has about 10,000 acres of land to protect. I believe in a small area to protect. We do not want a county organization; we want a township organization, and I would ask for the respectful consideration of the appointment of a United States patrolman for Tryon Township.

I would like to state right here that we do not think it wise to appoint any local man for the fire patrolman. We would rather have a man with the United States Government seal upon him, a man with the right to make arrests and a man that would be perfectly unbiased and not afraid to arrest any man, whether he is kin to him or not.

I ask your respectful consideration of this appointment.

DR. PRATT: Mr. Hall, have you ever coöperated directly with railroads?

MR. HALL: I think we have. Possibly Mr. Peters knows more about it than I.

DR. PRATT: Mr. Peters, have you ever coöperated in any way with the railroads, and how can we get them particularly interested in coöperative fire protection?

MR. PETERS: The best examples I know of are those where the Forest Service is coöperating with certain of the western railroads, as the Northern Pacific and Great Northern, which own large areas of timberland in some of our National Forests. Agreements have been entered into with these roads whereby the companies will keep clear of inflammable material a strip of varying width, as conditions may demand, up to 200 feet beyond the right of way, and to provide all locomotives which do not burn oil with suitable spark arresters and other standard equipment to prevent the dropping of fire. The protected strip is designated jointly by representatives of the railroad and the Forest Service. The work of clearing the strip satisfactorily, including disposal of all slash and refuse, is done by the railroads under the supervision of the Forest Service.

The actual fighting of fires is also provided for. Prompt notification is given to Forest officers of all fires discovered by railroad employees. Telephone lines to make this possible have been put up by the Forest Service, using the companies' poles wherever desirable. Warning whistles are sounded by locomotives when fires are discovered. Forces of fire fighters are assembled on the outbreak of fires, made up of Forest officers, railroad employees, and such temporary labor as can be gathered by either. Except for salaries of regular employees, the cost of fighting fires which start within 200 feet of the railroad is borne by the company, and of all others by the Forest Service, unless it is shown in the first case that the railroads were not responsible, or, in the second case, that they were responsible for the outbreak of the fire.

You will be interested to know that the Forester recently had a conference with President Harrison of the Southern Railway on the feasibility of coöperating with that company.

MR. HALL: I will say, Dr. Pratt, in regard to the plan that we are trying to work out with the Southern Railway, that we have agreed with the company to send a man over the various lines this fall to study the situation carefully, with the idea of making some practical recommendations to the company in regard to controlling fires on their right of way, and especially relieving the company of the damages to which it is now subject on account of fires started by railroad locomotives. We are looking for a good deal to come out of that study, and will be very much disappointed if we do not get something out of it that will be useful to the company, and perhaps useful to other companies which may operate under the same conditions.

A RAILROAD MAN: All the railroad companies throughout the country are extremely interested in any laws or acts that are passed by any Gen-

eral Assembly of any State in regard to the protection of forests and the prevention of forest fires. When a forest fire occurs near a railroad, the origin of that fire is immediately laid to the railroad, whether it was the cause or not. If it starts close enough to the railroad, the railroad is given the credit of starting that fire, and I do not doubt that there have been many damage suits brought against railroads for forest fires which they never started at all. Unable to prove much one way or the other, the juries have given the man who brought suit the benefit of the doubt. The railroads are also interested in the general protection of the territory through which they pass.

A TRYON MAN: The Southern Railway passes right across Tryon Township, which brings up the question as to how this company can coöperate in making the work of our association more effective.

Right at a glance, there would seem to be several ways in which the railroad could coöperate. For instance, it might give instructions that crews of trains going up and down the mountain, if they see a fire just started, shall, as soon as their train reaches a telegraph station, telegraph to headquarters that there is a fire; the company might then telegraph to other places to get assistance in putting out the fire. Again, section men might be instructed to extinguish fires not only on the right of way, but on each side of it to a reasonable distance.

MR. BISHOP: Between the local Southern officials and the administration of the Mount Mitchell National Forest there has been very satisfactory and quite complete coöperation. The reporting of fires has been carried on quite satisfactorily, and there have been no fires along that portion of the right of way which passes from Ridge Crest east through the Mount Mitchell area. I do not think they have paid one dollar in damages on that right of way, though Mr. Hardwick tells me that previously he had paid enough in damages to own the land.

MR. COBB: May I say a word in regard to railroad and local coöperation? In Tryon Township the Southern Railway has coöperated with our club admirably. Four of the nine fires that have occurred since the Tryon Forestry Club went into existence, nineteen months ago, undoubtedly occurred from locomotive sparks, and the section men have turned out and worked and have helped us in every way possible. They were instructed by their superintendent, or whoever the man in authority was, that they should give attention to any alarm of fire started by their locomotives, or in the immediate vicinity of their right of way, and they have done royally well.

MR. AYRES: I was interested in following what has been said. We do not even wait for a telegraph station up our way. The engineer gives five long blasts of the whistle, twice repeated, and the section men and other railroad employees and all who hear the signal know that there is a fire just as soon as the engineer has seen it.

MR. POWELL: It seems to me that we have the nucleus here for two live protective associations. Tryon has an association, and that might be reorganized along the lines suggested by Mr. Peters, with a view to enlargement as new members would come in. Mount Mitchell also makes an ideal area for a protective association. The State will own a considerable area on the mountain itself, while the lumber companies own large tracts of land surrounding it. Getting down to practical business, it seems as though we could agree on an organization for the Mount Mitchell area. A board of directors might designate definitely the area to be included, though always keeping in view the possibility of enlarging it. It does not seem to me that it would be practical to organize a number of small associations, and handle them effectively.

Two members of the Asheville Water Commission are present, and I have no doubt that, after hearing this discussion, they will be glad to coöperate in an association as outlined by Mr. Peters.

MR. STIKELEATHER: As a representative of the city of Asheville, I will supplement what Mr. Powell has said. We have 12,000 acres of land on the North Fork, and at present two wardens have care of that property. Naturally, the city of Asheville is in a somewhat difficult position for general fire protection. It has been necessary for us to fence our watershed to prevent cattle from ranging on it. In addition to this, we are now constructing a fire line around the larger part of the North Fork area. We have been forced to do this because the matter of fire protection for us is absolutely vital. That fire line will probably cost us more than the protection of 100,000 acres would cost under the plan proposed here; but, of course, you can see that fire protection is so vital that, in addition to the association that you gentlemen suggest, we must needs construct this for additional security. Our wardens naturally will coöperate with the wardens appointed by the Government or by the State, and if any concrete plan can be suggested by these various State and United States representatives by which a fire association can be organized, I shall be exceedingly glad to see that worked out. We will have to have an additional warden. I am wondering if a wire fence could be constructed around this property or if it would in any way work against fire protection generally.

MR. PETERS: I see no reason why it should. The only difference between your protection and the plan I have outlined is that yours is more intensive and a great deal better.

MR. STIKELEATHER: We have already had the coöperation of the United States Forest Service, and our men have coöperated with them. Of course, our men have other duties besides fire protection.

This protective insurance association that you suggest has interested me very much as an individual. It does seem to me that if an organization can be formed, charging, for instance, a premium of a cent an acre, it would work in Western North Carolina. There should be a warden in charge of the various properties, who would organize the work. He would visit and inspect the different parts of the area; would appoint patrolmen, and would organize a voluntary fire-fighting corps to be employed in the event of fire. There are probably fifty or one hundred large companies in Western North Carolina which are at present employing patrolmen. The expense of maintaining these men might be largely reduced if there could be some coöperation—a sort of voluntary fire department for service in the forest, such as is formed in cities where there is not enough money to support an entire paid department. If some gentlemen here can suggest a concrete plan by which such an association could be formed, there are, no doubt, many men here who would agree to pay the premium imposed, say, a cent an acre. I do not know how such an association could coöperate with the United States unless their patrolmen should have the same authority for arrest that is given to the United States wardens and the State wardens.

Speaking for Asheville, I have no authority to offer any sum from the city of Asheville to assist this movement. In regard to the Mount Mitchell area, I am satisfied that, in addition to the two paid patrolmen we now have and another we are placing on the Bee Tree Watershed, we might contribute additional funds for the work of patrolmen in that area generally. We now own almost exclusively the watersheds of Bee Tree and the various branches of the North Fork, which, with the additional areas that we will probably secure later, constitute approximately 18,000 acres. There are now 17,000 acres owned by the city of Asheville.

DR. PRATT: Coöperative forest protective organizations, which are virtually timber insurance associations, have proven feasible and practicable in other States, and I see no reason why there should not be an insurance association here for the protection of large timberlands, whether owned by corporations, lumber companies, or individuals. I should like to hear expressions of opinion from other owners. Mr. Winchester, what do you think of the general idea?

MR. WINCHESTER: I came here to learn, more than to give any instruction or information. My work has been largely devastation of forests, so far; but I want to get on the fence, or on the other side, to a certain extent.

My idea is to start this work and to start it quickly; to form an organization of the timber owners and other interested landowners in Western North Carolina, to prevent forest fires. The first work of that association should be a campaign of education and forest protection propaganda throughout the district. Then, on account of the wide territory over which the large timber interests are distributed, let them get up local organizations, for the time being, at least. That would be my idea of the most feasible plan at the present time, judging by what information I have picked up from those who are interested in the work. That starts the ball rolling. The company which I represent now owns only about 15,000 acres, and they are widely distributed.

DR. PRATT: What do you suppose you are paying out yearly now for patrol work?

MR. WINCHESTER: I could hardly tell you, because it has been quite widely distributed. We have given our foremen instructions whenever there is a fire started to take the necessary men to fight that fire. I have not investigated recently what the costs are or have been.

MR. WOOD: I concur with Mr. Winchester in his remarks. I came here for the purpose of learning the ideas of this meeting, rather than to suggest any. Our experience along the line of forest protection has been carried on solely by our own efforts. We are, in a sense, separated from other timber manufacturers, being located in the extreme western part of this State. Our area is quite large, and there are no active operations west of our holdings at this time. When forest fires have occurred, we have always taken care of them ourselves. It appears to me that in forming a forest fire association for the entire State of North Carolina it is undertaking too big a proposition. I think the State association should be subdivided into sections. We have a large State, and conditions in the eastern part are quite different from what they are in the Piedmont section, and conditions there are quite different from what they are in the western part. It seems, therefore, to me that each separate locality should be handled individually by subdivisions. I believe that more effective work and better results can be accomplished by local organizations, similar to what Mr. Lindsay spoke of as having been formed at Tryon. I believe that if some of the adjoining property owners would form small organizations they could more effectively main-

tain their patrolmen and watchmen by coöperating with the State and the United States Forestry departments. I do not think it is necessary to have lookouts employed the year around. The seasons of the year when the fires are most destructive occur during the spring and fall months. By maintaining patrolmen or watchmen during the dry seasons of each year, covering a period of four or five weeks in the spring and about an equal period during the fall, the danger season would be tided over. This, however, should be worked out on the association plan. Townships, if too large, should be subdivided and the patrolmen vested with the power to make necessary arrests. All fires should be reported promptly to the owners of the property. In order that no time shall be lost in reporting the location and size of the fire and in summoning sufficient men to control it, patrolmen should know where all available men may be found.

I believe that several small organizations will work to greater advantage than one State-wide one, because conditions vary so widely in the different parts of North Carolina.

MR. RAVENEL: I agree with Mr. Wood that this problem is essentially a local issue. There may be such communities as Tryon which will look after themselves, but for the most part the owners of lands who are willing to make some sacrifice for fire protection are widely separated.

But wherever there is National property, there exists already a system of forest protection with regular patrols, and this forms a nucleus for protection against fire. It seems to me that if the officers of the Federal Government and the State Government would formulate some terms upon which persons owning adjacent lands could come in for the same protection, that is, enlarge the scope of the plan already existing by adding to the area which has the benefit of fire patrol, a great many land-owners would comply with those conditions.

I know that in some of the areas the fires have been greatly diminished. In the region about Highlands, where I own timberlands, it has been marvelous the extent to which forest fires have been reduced, and there has been a good deal of voluntary work on the part of the Government officials in putting out fires which have not, in all instances, been on the Government property, but, of course, were a menace to their property.

We have with us one of those officers, who has made a brilliant record as a fire fighter, and I should like very much to hear from Mr. Fritz. I do not think any one could enlighten us more, and perhaps he can formulate some scheme along this line.

MR. FRITZ: I am afraid that Mr. Ravenel rather flattered me. Ever since I have been in the district to which he referred, I have felt the need of some coöperation with the private landowners. There are several small holdings, which lie adjacent to some of the Government lands, that should be protected, and indirectly are protected by the Government at the present time, but it is believed by our forest officers that the private owners should bear a part of the expense. It is hoped that from the results of this meeting we will be able to plan some well defined system by which we can coöperate in the protection of those lands.

MR. PERLEY: My situation is about like that of the Champion Fiber Company, as you will see if you take the trip over our logging railroad to Mount Mitchell. Patrol work is done by us only in the very dry season. We have been very successful this year and have not had any fires at all.

MR. PETERS: I would like to state for Mr. Wood's information that although I said nothing about the protective work being conducted only during the danger period, that was understood.

MR. FINLEY: I am just studying, thinking, and comparing ideas with the rest of you gentlemen. I do not know, but it appears to me that we could work out a system something like this: Let us have local associations, as suggested, and let them coöperate with the State and the Federal Governments, the expenses of the local association to be borne partly by the United States, partly by the State, and partly by the local owners. In other words, let it be mutual all the way around. If the owners paid all the expense, possibly they might think it was a little too hard; and if the State has enough money it could pay part. The United States, of course, could pay anything it wants to, but it does not want to make the State feel badly; therefore, it does not pay more than the State pays. Of course, the owners are not able to pay much, because many of them are land-poor. Therefore, it seems to me that the coöperation ought to be all around.

Now, my county, the county of Wilkes, or rather the "State of Wilkes," as it is often called, has an area of about 700 square miles. A large timber company in the west end of the county owns 60,000 acres, while one in the east end of the county has 24,000 acres. In addition to this, there are smaller properties needing protection in this and near-by counties amounting to 25,000 or 30,000 acres more, while many small tracts all along the Blue Ridge might be brought in. Here might be a local organization. The large owners generally have men looking after the timber. They have men to look after fires, trespass, and all sorts of business; in

other words, they look over the land every few days. But if this fire protection was combined with the general forest supervision it would be a great feature, it strikes me, and hundreds of thousands of dollars would be saved every year by having it properly looked after, with the Government and the State behind it.

MR. AYRES: I would like to say that the plan up our way has worked out exactly as he said, although we do not share expenses just as the gentleman mentioned, but the three forces do work together.

MR. PETERS: Mr. Chairman, referring to what Mr. Finley has just said, as I understand it, each company he referred to has a man to do work of a protective character. Now, it might be possible to effect a combination so that if, for example, there were five concerns, employing five men, the combination, or association, if you please, would employ only three men, thus cutting down the cost of the work by the amount paid to two men. That is one of the very practical features of the association plan.

MR. HOLMES: I want to ask Mr. Finley a question. I have had a letter from Mr. Smoot; I have been in close correspondence with him for a while, and I think his is one of the large companies that you speak of?

MR. FINLEY: He is one of the largest and owns quite a good deal of land.

MR. HOLMES: Mr. Smoot has promised close coöperation in fire protection. Now, what I wanted to ask was, Do you know of any other landowners who would come in on any close coöperative scheme in the way Mr. Smoot will, so that we can start an area in Wilkes and Surry counties?

MR. FINLEY: I am satisfied that we could start a local organization if Mr. Smoot would coöperate; and then if we could get the Grandin Lumber Company in with the 60,000 acres, it would be quite an addition. The company with the 24,000 acres, which already has this kind of supervision to some extent, might also be brought in. But I am satisfied we would be able to have one or two organizations, whichever is feasible. Whether it would be better to have one or two organizations is a matter to be worked out, but I am satisfied that we could certainly have one right in the center. Some time ago, with the advice of the North Carolina Geological and Economic Survey, we organized the Wilkes County Forest Protective Association, but it has never done any real protective work.

MR. HOLMES: I understand that the Grandin Lumber Company is not in a position to take this matter up just at the present time. I trust that they will come in, however, in the near future.

What we want to do is to start fire protection this fall—if possible, by the middle of September. We want to get just a nucleus, if it is only two or three contiguous landowners. The idea is to get some definite point from which we can work up a coöperative area so that one or more patrolmen may be appointed on several different areas during the fire season this fall.

MR. ASHE: Since you must have a nucleus to work upon, why could not this meeting adopt a plan for the State and the Government to coöperate with any two or more adjoining or near-by owners who have an aggregate area of not less than 10,000 acres, making that acreage the minimum area for coöperation and a local association? Any timberland owner in the State might seek coöperation with his neighbors in order to secure the necessary acreage, and the assessment cost of patrol should not exceed 1 cent an acre. The Chief State Fire Warden should have the power to appoint the patrolmen, who would be State officers, having power to arrest, their salary being fixed by the Federal Government. Each such local association could have the right to have a delegate to the central association. That would create local organizations, give local self-government, and make local interest. Such a basis would serve at the start, and would give any one an opportunity to form a local association. There might be several such associations in the vicinity of Asheville. Mr. Finley could start one or more in Wilkes County. He would have some assurance of success. If another association were started in Mitchell County, that would be another nucleus even if only two owners entered it. There should be at least two owners, so that it would not be a personal matter. One owner should certainly be able to interest a neighbor; or three owners might be made the minimum. It seems to me that there would be a possibility of working up quite a number of local organizations in this way.

MR. PETERS: I think Mr. Ashe's idea is all right. Personally, I would not go quite so far at the beginning. My idea would be to encourage the organization of an association in an educational way. I do not believe that you can effect an organization of timberland owners for the whole of western North Carolina at this meeting. I think the interests represented here are too far separated; but I do think that you gentlemen who are interested—and I hope all of you are—can work up sentiment among your neighbors and in that way endeavor to form a combination.

For the present, we should not hesitate to coöperate with the individual owner. Of course, where two or more owners can be brought together that would be preferable to individual coöperation. But rather than not coöperate at all, I think we should go ahead and start with the individual.

The idea would be to coöperate with the owner who will in good faith show interest in the work and give a reasonable amount of attention and funds. If a neighbor wishes to do likewise, combine with him; and if another wishes also to come in, we have a combination of three; and so on. What we want is to get something started. I am firmly convinced that if we get started the work will progress as a result of its value being demonstrated.

MR. AYRES: I make a suggestion now, which possibly might be put in the form of a resolution: that an account of this Conference be drawn up by the State Forester, with an announcement of the plan of organizing local district protective associations, such as have been suggested, of two or three or a number of landowners, and expressing the willingness of the State Forester and the Federal Government to coöperate where such associations can be organized, and that he issue that information by letter or circular to as many timberland owners as he can get in touch with in the State.

Motion seconded and carried.

DR. PRATT: We shall have to bring this Conference to a close, but before we do, I want to say that the Geological Board and the United States Forest Service would like very much for any one here representing corporation or individual landowners, who wishes to consider this coöperation between the Federal Government, the State, and themselves, to see Mr. Holmes or Mr. Peters before they go away. We can then, perhaps, get something started, and we will find out what they can do or will do.

When you go back home and take the question up with the people in your district, you can get them to promise coöperation, and then take the matter up with the Geological Board at Chapel Hill. Final arrangements can then be made for organizing a coöperative fire protective area.

If any of you here will take up this question before we go, arrangements can probably be made for either a State or Federal forest officer to visit your section, look the ground over and make suggestions regarding what form of coöperation can be taken up and put into effect.

Following the conference, some informal discussions with certain possible members of proposed associations were held. As a consequence the following suggested plan of organization was drawn up. This is now being submitted to the various landowners concerned for their approval.

This outlined plan can, and undoubtedly will, be changed in many minor details, but probably not very much in its essentials. It is given here as a good example of the kind of coöperation which is proposed between timberland owners, the State, and the Federal Government.

A PROPOSED WORKING OUTLINE FOR THE SUGGESTED MOUNT MITCHELL FOREST PROTECTIVE ASSOCIATION.

OBJECT.

To protect the lands, timber, and other property of the members from fire. The present plan includes the fall fire season of 1915. Runs to December 31, 1915.

MEMBERS.

Any firm, corporation, or individual owning property within the area to be protected may become a member by signifying his or their willingness to comply with the hereinafter set forth conditions. The policy to be to extend the influence of the Association over as great an area as possible. Persons owning as much as one hundred acres of land should be encouraged to join.

ORGANIZATION.

Field work to be in charge of the supervising forest officer of the Mount Mitchell purchase area. He to be known as Chief Warden and to be appointed Township Forest Warden by the State of North Carolina. Service rendered without cost to the Association.

Under the Chief Warden, and also appointed Township Forest Wardens by the State, will be:

a. **PATROLMEN (5).** To spend time patrolling their districts, put out such fires as they can, give immediate information as to others, at such times during the danger season as is practicable, spend time building trails, etc. Paid by day, week, or month.

Districts.

No. 1. From Perley & Crockett Mill to Pinnacle Ridge. Should stay at Long Gap. Phone available. Should probably be Buncombe County man. Black Mountain Township.

No. 2. From Pinnacle Ridge to north end of Perley & Crockett operation on east side of the Black Mountain. Should stay at camps near commissary. Handy to phone. South Toe Township.

No. 3. Perley & Crockett operation on west side of ridge. Should live at Camp No. 9. Phone available. Pensacola Township.

No. 4. Swannanoa Township and to Ridge Crest. Mainly along north side of Southern Railway.

No. 5. Big Ivy and Shope Creek District (under Federal patrolman).
Big Ivy Township.

b. FOREMEN. To be appointed District Forest Wardens to take charge of fire fighting when a fire occurs that cannot be put out by patrolman. Should be several for each district, if available. Each should be assigned a subdistrict. To be paid a retaining fee of \$5 per year in advance and then by the hour for time actually spent fighting fire at the rate prevailing in that locality for such services, but not to exceed 20 cents per hour. To be appointed District Forest Wardens. Must know how to fight a fire and how to handle men.

ESTIMATE OF COSTS.

September, 1915, to January 1, 1916.

I. General Expenses:

Patrolmen, 4 at \$45 per month, 2 months.....	\$360.00
Foremen, 10 at \$5 each.....	50.00
Emergency fire fighting and general fund.....	200.00
Total	\$610.00

II. Improvements:

1. Trail, Bald Knob to Potato Knob, 2 miles.....	\$400.00
2. Trail, Mount Mitchell to Potato Knob.....	75.00
3. Tool boxes, supplied with tools, 6 at \$20 each.....	120.00
Total	\$795.00

Explanation of above items not already taken up in detail:

General Expenses:

Emergency fire fighting and general fund.....\$200

This fund would provide for the costs of fighting any fire which burned on land not included in the Association. Such fires would be fought only if they endangered the land of the members. Also provide for any general expenses.

Improvements:

1. Trail, Bald Knob to Potato Knob.....\$400

This trail is needed as a means of communication and as a fire-break. Would be of great value to the Federal Government in connection with the administration and protection of their land; of great value to the city of Asheville in connection with the protection of their watershed, and of much value to the public generally, especially the Montreat Association and town of Black Mountain. Would benefit Mr. Dunn greatly.

Should be built at once. All equipment can be supplied by the Forest Service. Should be 3-foot trail; 10 per cent grade, well drained, free from loose rock, carefully located.

2. Trail, Mount Mitchell to Potato Knob-----\$75

There is a poor trail over this distance now. It should be worked over again. Is full of logs, laps, etc. Would be of great general value as a patrol line and means of communication.

3. Tool boxes filled with tools, 6 at \$20 each-----\$120

One of the first things in fire protection is to have suitable tools available.

Each box should contain :

- 2 axes.
- 2 mattocks.
- 2 lanterns (filled).
- 3 water pails.
- 2 water bags.
- 12 potato hooks.
- 1 cross-cut saw.

Boxes located at :

- Long Gap.
- Where first commissary was.
- Rock Creek.
- Stepp's Gap.
- Under Rainbow Gap.
- Swannanoa Township.

List of Probable Members and Property Owned by Each.

NAME.	ACREAGE.	REMARKS.
Brown Brothers.....	3,000	Stumpage owned by Dickey & Campbell.
Highland Spruce Company.....	9,000	Stumpage under contract to Dickey & Campbell and Perley & Crockett.
City of Asheville.....	17,000	Largely under protection at this time. Only about 2,000 acres would come under the influence of this plan.
Montreat Association.....	4,000	
Burke Tanning Company.....	2,000	
Bee Tree Lumber Company.....	3,000	
United States.....	10,000	
Small tracts.....	3,000	—or so. Several on Mineral Fork which will no doubt come in.
Total.....	51,000	

DISCUSSION OF PROBABLE MEMBERS.

Brown Brothers. By a protective association this firm would profit inasmuch as they own the fee in the 3,000 acres of land upon which Dickey & Campbell own the stumpage. This stumpage is now being operated by Perley & Crockett. Thus in the protection of the spruce belt of the Brown Brothers tract, three companies are benefited.

Highland Spruce Company. This company owns the land and stumpage. The softwood stumpage is under contract to Dickey & Campbell

and is relet by them to Perley & Crockett. In the protection of this tract three concerns would be benefited.

City of Asheville. While the city owns some 17,000 acres in the locality covered by this plan, the most of their land is under adequate protection at this time, and they should not be asked to contribute funds on the basis of all they own. Some several thousand acres of their land, however, can be best protected in connection with the lands covered by this plan.

Montreat Association. The portion of this property which is most apt to burn over is the part along the logging railroad. This can be protected very advantageously in connection with the Burke Tanning Company land just across the Blue Ridge.

Burke Tanning Company. Two thousand acres on Mill Creek. Burns over nearly every year. Can be protected in connection with the Montreat lands.

Bee Tree Lumber Company. Three thousand acres on Revis Creek. Virgin timber land. Can be handled together with the Big Ivy tract. R. B. Brank should be appointed foreman.

United States. Big Ivy tract, Burlison lands on North Fork of Ivy, Dr. Ambler lands and Ward & Nichols tract.

Small Tracts. Owned by several parties in Swannanoa Township principally.

Table Showing Estimated Expenses and Suggested Apportionment Among Members.

	City of Asheville.	Brown Brothers.	Highland Spruce Company.	Dickey & Campbell.	Perley & Crockett.	Montreat Association.	Burke Tanning Company.	Bee Tree Lumber Company.	United States.	State and Federal Aid.	Any Other Source.	Total.
Amount owned—acres—	*17,000	12,000	owned jointly.			4,000	2,000	3,000	9,500		3,000	50,500
LIST OF EXPENSES.												
Trail—Bald Knob to Potato Knob.....	\$ 100	\$...	\$...	\$...	\$...	\$ 50	\$...	\$...	\$200	\$...	\$ 50	\$ 400
Trail—Mount Mitchell to Potato Knob.....			10		10				25		30	75
Tool boxes.....	20	5	20	20	20	5	5	10			15	120
General expenses.....	50	20	50	80	120	25	25	25		125	90	610
Totals.....	170	25	80	100	150	80	30	35	1225	125	185	1,205

*Includes Bee Tree tract, which is just now being acquired by the city.

†In addition to furnishing the patrolman on the Big Ivy District.

‡This amount would have to be raised largely in Swannanoa Township or from the Weeks Law fund.

CONDITIONS.

Each member to subscribe toward maintenance of the Association according to the benefits derived. Chief Warden to suggest apportionment of expenses. In case of a deficit, an assessment to be made in proportion to original subscription. Each member to pay for putting out fire on his or its land or caused by him.

Expenditure of funds to be subject to the approval of the Forestry Board of the State on the order of the Chief Warden.

Spark arresters inspected each day and report sent owner. Inspected by Chief Warden from time to time. Trainmen to put out any fire seen. If help is needed, blow for section men.

Tools should be carried on each engine.

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, 1915. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents.*

25. Zircon, Monazite, and Other Minerals Used in the Production of Chemical Compositions Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D. *In press.*

ECONOMIC PAPERS.

1. The Maple-sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virginina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of

Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Prof. Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads Are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina During 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina During 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties, with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a List of Gems and Gem Minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems occur, as taken from United States Geological Survey Report, by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin, and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos, describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin Mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31 and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey—Statistical Report of High-

way Work in North Carolina During 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by George R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina During 1914, and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of the Seventh Annual Drainage Convention held at Wilson, N. C., November 18 and 19, 1914. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. 8°, -- pp. *In press.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magneslan Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley, 1915. 8°, -- pp., 30 pl., 262 figs., 1 map.

BIENNIAL REPORTS.

First Biennial Report. 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking-waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county-seats in North Carolina; list of Magnetic Declinations at the county-seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the U. S. Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on forest fire conditions in the southeastern States, by J. S. Holmes. Report on the work of the U. S. Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, post-office address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 43

PROCEEDINGS
OF THE
SECOND GOOD ROADS INSTITUTE

HELD AT THE
UNIVERSITY OF NORTH CAROLINA
FEBRUARY 23-27, 1915

Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary

*Held under the Auspices of the Departments of Civil and
Highway Engineering of the University of North
Carolina and the North Carolina Geo-
logical and Economic Survey*



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1916

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., November 1, 1915.

*To His Excellency, HONORABLE LOCKE CRAIG,
Governor of North Carolina.*

SIR:—The second Road Institute was held at the University of North Carolina, February 23-27, 1915, under the auspices of the State University and the North Carolina Geological and Economic Survey. This second Institute opened with a good attendance and many subjects of vital importance to the road work of the State were discussed with much benefit to the road engineers, superintendents, county commissioners, etc., in attendance. It is believed that the proceedings of this Institute should be put in permanent form and I am, therefore, submitting its proceedings for publication as Economic Paper No. 43 of the publications of the North Carolina Geological and Economic Survey.

Very respectfully,

JOSEPH HYDE PRATT,
State Geologist.

Geological & Economic Survey 8-7-169

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PROCEEDINGS
OF
SECOND ROAD INSTITUTE
HELD AT
UNIVERSITY OF NORTH CAROLINA
FEBRUARY 23-27, 1915

INTRODUCTION

A resolution was passed by the first Road Institute, held March 17-19, 1914, requesting that the University of North Carolina and the State Geological and Economic Survey make the Goods Roads Institute a permanent affair, so that the road engineers, superintendents, road commissioners, county commissioners and others interested in road building throughout the State could get together and hear discussions of the various road problems to be met with in North Carolina and thus try to bring about improved methods of road location, administration and construction.

In accordance with this request, the North Carolina Geological and Economic Survey sent out the following letter to the road officials of the State:

January 20, 1915.

MY DEAR SIR:—Because of the success of the Road Institute which was held at the University of North Carolina in March, 1914, it has been decided to make the Institute an annual occurrence, and in 1915 it will be held during the week beginning Tuesday, February 16th. The Institute will last four days and special notices regarding the program will be sent out later.

This Road Institute is considered a clearing house for road problems in North Carolina, and is of very great value to all those connected with road work in this State. I am writing to ask that your board take up the question of detaching your road engineer or superintendent, or both, to the Institute and provide for the payment of their expenses, considering their attendance as part of their official duties. I believe the good which will result from the knowledge gained by the engineer will more than offset any expense. We should also like very much to have one or more members of your board in attendance at the Institute. Last year there were 24 counties represented and all were enthusiastic over the meetings and the continuance of this Institute. I will appreciate it if you will let me know what action you take regarding the above, and sincerely hope that you can act favorably upon detaching your engineer, superintendent, or other road officials to attend the Institute; and also that you will be able to attend yourself.

With best wishes, I am

Cordially yours,

JOSEPH HYDE PRATT,
State Geologist.

In giving notices to the press in regard to the institute, it was stated that while the subjects of "Sand-clay and Topsoil Roads," "Maintenance of Highways," and "Culverts" would be given special consideration, other problems relating to road building, such as road location, worn-out macadam roads, bituminous compounds, contracts and specifications, blasting materials, etc., would come up for discussion.

There was an increased attendance at this Road Institute as compared with the first one. The number of registrations was 80, with 29 counties represented, as follows:

Alamance	Greene	Orange
Anson	Guilford	Rockingham
Alleghany	Halifax	Rowan
Craven	Harnett	Sampson
Cumberland	Henderson	Vance
Davidson	Hoke	Wake
Duplin	Iredell	Warren
Durham	Lee	Wayne
Edgecombe	Mecklenburg	Yancey
Forsyth	New Hanover	

The following are the names of those who registered at this second Road Institute:

LIST OF MEN ATTENDING GOOD ROADS INSTITUTE

Name	Address	Title	County	Company
Arnold, J. H.	25 Rowland St., Richmond, Va.			John Baker, Jr., Road Oil and Ashphalt.
Baity, H. P.	Harmony		Iredell	
Blackmer, W. S., Jr.	Salisbury		Rowan	
Borden, J. C.	Goldsboro	Trustee	Wayne	
Boren, G. S.	Pomona		Guilford	Pomona Terra Cotta Co.
Breeze, V. W.	Durham		Durham	
Brooks, Benj.	Kansas, City, Mo.			International Clay Products Bureau.
Brown, D. Tucker	Chapel Hill	Engineer	Orange	
Brown, R. T.	Chapel Hill	Engineer	Orange	
Burnett, R. A.	Wilmington	Superintendent	New Hanover	
Carr, W. E., Jr.	Durham		Durham	
Cobb, Collier	Chapel Hill		Orange	
Cobb, Collier, Jr.	Chapel Hill		Orange	
Coble, R. P.	Sanford	Engineer	Lee	
Cosby, J. W. H.	Reidsville	Engineer	Rockingham	
Craven, E. F.	Greensboro		Guilford	
Croom, A. E.	Wallace		Duplin	
Crosby, W. W.	Baltimore, Md.	Engineer		
Davidson, J. A.	Greensboro	Superintendent	Guilford	
Drane, B. S.	Charlotte	Engineer	Mecklenburg	

Name	Address	Title	County	Company
Eagle, D. E.	Statesville		Iredell	
English, F. M.	Pittsburgh, Pa.			
Fallis, W. S.	Henderson	Engineer	Vance	
Ferrell, R. M.	Durham	Patrolman	Durham	
Fields, B. L.	Greensboro		Guilford	
Fleming, Wm. R.	Cincinnati, O.			Newport Rolling Metal Culvert Co.
Flowers, G. W.	Durham	Chairman Board County Commissioners	Durham	
Fore, C. L.	Charlotte		Mecklenburg	
Galvin, Geo. P.	Wilmington			Carolina Metal Products Co.
Harper, Henry	Charlotte		Mecklenburg	
Hickerson, T. F.	Chapel Hill	Engineer	Orange	
Higdon, R. W.	Fayetteville		Cumberland	Salisbury Metal Culvert Co.
Higgins, C. W.	Greensboro		Guilford	
Hines, C. P.	Hillsboro		Orange	
Hocutt, H.	Gerton	Superintendent	Henderson	
Hogan, H. C.	Chapel Hill		Orange	
Holder, B. B.				
Homewood, R. M.	Burlington		Alamance	
Hughes, Jr. N. C.	Weldon	Engineer	Halifax	
James, Robt. L.	Chapel Hill		Orange	
Johnson, R. N.	Snow Hill	Engineer	Greene	
Kiker, W. B.	Durham		Durham	
Koerner, H. R.	Raleigh		Wake	Carolina Metal Products Co.
Lilly, E. J., Jr.	Fayetteville		Cumberland	
Lilly, H. M.	Raeford		Hoke	
Long, S. L.	Chapel Hill		Orange	
McAllister, J. C.	Wilmington	Superintendent of Streets	New Hanover	
McGregor, J. D.	Wadesboro	Superintendent	Anson	
Martin, J. W.	Tarboro	Superintendent	Edgecombe	
Miller, C. M.	Salisbury	Engineer	Salisbury	
Mullican, N. S.	Winston-Salem	Engineer	Forsyth	
Mullis, Ira B.	Lumberton	Engineer	Harnett	
Patterson, H.	Burlington		Alamance	
Pennell, J. Roy	Snow Hill	Engineer	Greene	
Peyton, Wythe M.	Burnsville	Engineer	Yancey	
Phipps, J. L.	Greensboro		Guilford	
Plott, J. T.	Greensboro		Guilford	
Pollard, J. M.	Durham	Superintendent	Durham	
Price, T. M.	Madison	Engineer	Rockingham	
Pratt, Joseph Hyde	Chapel Hill		Orange	
Quevedo, Manuel	Greensboro		Guilford	
Richardson, E. G.	Charlotte		Mecklenburg	
Schlitz, M. M.	Charlotte		Mecklenburg	

Scott, Sam D.....	Warrenton.....	Engineer.....	Warren.....	
Shields, E.....	Salisbury.....		Rowan.....	
Slaughter, J. H.....	Newport, Ky.....			
Smith, John E.....	Chapel Hill.....		Orange.....	
Snowden, R. E.....	Snowden.....	Engineer.....	Craven.....	
Spalding, J. J., Jr.....	Baltimore, Md.....			
Spoon, W. L.....	Burlington.....	Engineer.....	Alamance.....	
Squires, J. H.....	Wilmington, Del.....			
Teer, Nello F.....	Durham.....	Contractor.....	Durham.....	
Varner, G. C.....	Greensboro.....			Dixie Culvert Co.
Whitfield, F. M.....	Atlanta, Ga.....			Barber Asphalt Paving Co.
Whitfield, L. E.....	Clinton.....		Sampson.....	
Wicker, W. S.....	Elon College.....		Alamance.....	
Wood, J. W.....	Greensboro.....		Guilford.....	Dixie Culvert and Metal Co.
Wright, R. H., Jr.....	Nashville, Tenn.....		Davidson.....	

SCHEDULE OF LECTURES *

TUESDAY, FEBRUARY 23.

10:00 A. M.-1:30 P. M. Registration in Peabody Hall. Assignment of rooms.

2:30 P. M. Formal opening of the Institute.

Address—President GRAHAM, of the University of North Carolina
Purposes of the Institute—JOSEPH HYDE PRATT, State Geologist
and Director of the Institute.

3:30 P. M. LOCATION, DESIGN, AND CONSTRUCTION OF ROADS.

Short papers as follows:

Considerations Governing the Proper Location of Roads—T. F. HICKERSON, Associate Professor of Civil Engineering of the University.

The Effect of Grades Upon the Location and Design of Roads—D. TUCKER BROWN, Director of the North Carolina Good Roads Association.

Economical Method of Moving Earth in Road Construction—N. C. HUGHES, JR., Highway Engineer of Halifax County.

Economical Methods of Moving Rock in Road Construction—W. S. FALLIS, Highway Engineer of Vance County.

Economical Methods of Handling Surfacing Materials—R. P. COBLE, Highway Engineer of Lee County.

Discussion.

8:00 P. M. Smoker in Peabody Building.

WEDNESDAY, FEBRUARY 24.

9:00 A. M. SAND-CLAY, TOPSOIL, AND GRAVEL ROADS.

Address by C. M. STRAHAN, Professor of Civil Engineering and
Director of Road Department, University of Georgia.

*All lectures are to be given in Auditorium of Peabody Building.

- 10:30 A. M. *Sand-Clay and Topsoil Roads in Franklin and Vance Counties—*
W. S. FALLIS.
- 11:00 A. M. *Sand-Clay and Topsoil Roads in Craven and Wayne Counties—*
R. E. SNOWDEN.
- 11:30 A. M. *Sand-Clay and Topsoil Roads in Orange County—*R. T. BROWN,
Highway Engineer.
- 12:00 M. Discussion of *Present Conditions of Sand-Clay and Topsoil*
*Roads in North Carolina—*Discussion led by D. TUCKER BROWN
and S. D. SCOTT, Highway Engineer of Warren County.

WEDNESDAY AFTERNOON.

- 2:30 P. M. Inspection and study of samples of materials used in the con-
struction of Sand-Clay and Topsoil Roads.
Informal meeting in the Road Materials Exhibit Room, New
West Building—In charge of T. F. HICKERSON of the Engineer-
ing Department. and J. E. SMITH of the Geological Depart-
ment of the University.
- 3:30 P. M. MACADAM ROADS.
Is the Water-bound Macadam Out of Date?
Worn-out Macadam Roads: What Shall Be Done With Them?—
GILBERT C. WHITE, Consulting Engineer, Durham, N. C.
*Bituminous Compounds in Road Construction—*Representatives
of the Barber Asphalt Company.
- 4:15 P. M. *Contracts and Specifications—*BRENT S. DRANE, Consulting En-
gineer, Charlotte, N. C.

WEDNESDAY EVENING.

- 8:00 P. M. Entertainment, under auspices of the Community Club of Chapel
Hill.

THURSDAY, FEBRUARY 25.

- 9:00 A. M. MAINTENANCE OF ROADS.
Introductory remarks by Director of Institute.
- 9:20 A. M. REPORTS FROM COUNTY ENGINEERS, SUPERINTENDENTS, ETC.
W. S. Fallis, for Franklin and Vance counties.
R. P. Coble, for Lee County.
R. E. Snowden, for Craven and Wayne counties.
N. C. Hughes, Jr., for Halifax County.
Ira B. Mullis, for Harnett County.
R. T. Brown, for Orange County.
Sam D. Scott, for Warren County.
J. M. Pollard, for Durham County.
J. A. Davidson, for Guilford County.
D. P. Hutchison, for Guilford County.
R. A. Burnett, for New Hanover County.
Charles H. Neal, for Buncombe County.
J. B. Roach, for Iredell County.
J. B. Clingman, for Madison County.
James B. Price, for Rockingham County.
W. L. Wiggs, for Wake County.
W. P. Eddleman, for Cleveland County.

- J. Roy Pennell, for Greene County.
 Wythe M. Peyton, for Yancey County.
 C. M. Miller, for Stokes and Rowan counties.
 J. W. Martin, for Edgecombe and Columbus counties.
 F. P. Tate, for Burke County.
 John Spinks, for Stanly County.
 D. S. Harmon, for Forsyth County.
 T. L. Ware, for Gaston County.
 J. M. Burrage, for Cabarrus County.
 F. G. Hines, for Martin County.
 J. C. Cooper, for Wilson County.
 J. N. Ambler, for Davie County.
- 11:00 A. M. Address by W. W. CROSBY, Consulting Highway Engineer, of
 Baltimore, Maryland.
 Maintenance of Sand-Clay and Topsoil Roads.
 Maintenance of Gravel Roads.
 Maintenance of Water-bound Macadam Roads.
 Maintenance of Bituminous Macadam Roads.
 Maintenance of Dirt Roads.
 Suggested Systems of Maintenance.
- 12:00 M. *Methods Used in Maintenance of Capital Highway* (Illustrated)
 —D. H. WINSLOW, of the United States Office of Public Roads.

THURSDAY AFTERNOON.

- 2:30 P. M. BRIDGES AND CULVERTS.
Economy in the Design of Highway Bridges—
Relation of Contractor to the Highway Commission and to the
*Highway Engineer—*Engineer from Bridge Company.
Culverts: Terra-Cotta, Concrete, Corrugated Iron and Cast
Iron—
*Specifications for Culverts—*R. F. EZZELL, Chief Engineer of
 Maintenance, Southern Railway.
*Kind of Culverts—*By Representatives of:
 Pomona Terra Cotta Company.
 The Newport Culvert Company.
 The Carolina Metal Products Company.
 The International Clay Products Bureau.

THURSDAY EVENING.

- 8:00 P. M. *Good Roads in Other Lands* (Illustrated Lecture)—Professor
 COLLIER COBB.

FRIDAY MORNING, FEBRUARY 26.

- 9:00 A. M. *Blasting Materials.* A discussion of the different kinds of blast-
 ing materials and the most effective application of these to
 different classes of excavation—By Engineer from the DuPont
 Powder Company.
- 10:00 A. M. *Relations that Should Exist Between State Highway Commis-
 sion, County Highway Commission, and Township Highway
 Commission, and Relations of Highway Engineers to These—*
 By M. H. STACY, Dean of University, and JOSEPH HYDE PRATT,
 State Geologist.

12:00 M. **BUSINESS MEETING.**
How to Improve the Institute.
Correspondence Courses—Are They of Value?
Plan of Coöperation for the Employment of Engineers, Superintendents, and Foremen.

TUESDAY MORNING, FEBRUARY 23, 1915.

9:30 o'clock.

Address of Welcome

The Institute was welcomed to the University by President Edward Kidder Graham, as follows:

Mr. President, Ladies and Gentlemen:

It is a great pleasure to the University to have you gentlemen back with us once more. There are a number of reasons that instantly spring to my mind as to why the University of North Carolina should welcome the Roads Institute as a permanent part of its activities. One of these is that you are good roads men—public good roads men—and I think that if we carry out our purpose at all we are not only in favor of good public roads, but of good public anything, that, in fact, is our business.

We are in favor, as I understand our business, of good public anything from the standpoint, not of emotion, but of knowledge. That is, we are trying to find out what things are true and of good report, and in a large way we are trying to find out why those things are so, and what is the best way of bringing those things about. Now, if I understand the object of the Good Roads Institute, it exists exactly and precisely for that reason. It is not only in favor of a good public enterprise, but it is in favor of finding out most expertly and exactly what that good public enterprise really needs to make it a better public enterprise. That is what I understand by education. It is translating a thing that people, in a vague and general way, consider to be a good thing into an actual, realizable fact.

The speaker then discussed briefly the enormous amount of money to be spent this year in the South in the construction of new public roads, and then continued:

If you will look at the great inventions of the last century or two, you will find that those great inventions and discoveries have all been concerned with one thing: they have been concerned with making more easy communication between man and man. If I should ask you the greatest discovery of the last century you would say, perhaps, the steamboat—making it possible for men to communicate with each other over the water. In some fashion we got the boat there and then human ingenuity tried to make that boat a better instrument of communication between man and man, country and country. We took a box and put it on wheels and we put power in those wheels and produced the locomotive, and we said we have got to make the road that that thing runs on a freer, more facile thing, a better communication between man and man. But we were not satisfied with that. We said we will take the air that is freer and more facile still, and we invented the telegraph, the telephone and wireless telegraphy.

Now I say that all of those things, all those discoveries and inventions, may be reduced to a single thing—the effort of man, through his ingenuity and intelligence, to make more communicable the good things of intelligence, bodily comfort and material welfare between man and man. We are interested in mainly one thing, and that is in making more communicable the good things that we have each found.

I suppose if a man would ask you the greatest public enterprise that has been realized in your recollection, you would say the Panama Canal. What is that? Nothing but an international good road. For what purpose? Why, for making more communicable the good things of the east and west. If I were to ask you what is the Atlantic cable, I suspect you would answer in the same terms: It is an international good road for flashing communication from country to country. To the wireless telegraph station, which we have up here in one of our buildings, you can go tonight and hear the latest thrill from the European war, or find out what sort of weather we will have tomorrow—a wonderful invention for putting men into communication with each other.

So, this educational institution is an instrument for making communication more facile and more powerful between this age and the last age, this country and another country. We are interested in the question of not only making water and air an avenue of communication—we are interested in the good roads of the spirit. That is our business.

When you come to roads, such as the one that runs in front of this building, you have there not nearly so romantic and interesting a project in the advance of the human spirit, but you have a practical and a workable instrument for bringing men into communication with each other. Certainly if it is not as stimulating to the human imagination, it is a tremendously serviceable instrument to the men and women of our country trying to find out how to live together most profitably and amicably.

One of the greatest discoveries of our own time, from the public point of view, is the discovery of the public good road as an instrument in good government. But I am not going to take up your time explaining the fundamental relation that the good road bears to the school, to the church, to the doctor, to the merchant, to the manufacturer. This has been done many times and it has been clearly shown that it is the necessary servant of all of our public enterprises. Our interest in the good roads now, and, for that reason, my particular interest in the Good Roads Institute, is not for purposes of exhortation and evangelization. We have a bigger problem than that of trying to convert somebody to the general doctrine of good roads. Of course that has to be done; but something else that a democracy demands of us that we do not so constantly bear in mind, is that when the public turns down many of our enterprises it turns them down not because it believes that our general idea is bad, but because we have not worked it out in terms the public is willing to accept. The public is a hard-headed person; it asks that its public problems finally be worked out in a scientific way.

The public road problem now is primarily one for the expert, for the scientist. It is for that reason public road institutes of this sort are extremely important. We do not need so much to be exhorted to believe that good roads are a good thing for the people, as to find out what sort of roads are good and why. It is to finding this out and finding it out under all of the complex conditions that affect the goodness of a road that you gentlemen

are giving a large part of your lives. The question of good roads is about the biggest question that the people of North Carolina have before them. They cannot answer that question except in a muddled fashion, for the simple reason that the complete answer is a technical and scientific answer that involves study and experience that belongs to the expert. Evangelization and popular propaganda for good roads is necessary, but it is only the first step; the solution of the problem of roads for the commonwealth depends on the difficult science of permanent road building that you have come here to study.

The telephone, the wireless telegraph, aeroplanes and all the rest of the instruments of human communication are romantic and thrillingly interesting; but the most important of these open avenues of commerce and friendship is and always will be the good country road. It has improved very slowly; it has been neglected and left to go where it chose and be as bad as ignorance and indifference could make it. But you are changing all of that and the people are giving you great sums of money as an expression of their confidence in the public road as a fundamental public utility, and in you as intelligent public servants, who will make the science of road building a field of genuine statesmanship.

Purposes of the Institute

JOSEPH HYDE PRATT, Director.

All of you consider this now as part of the University of North Carolina inasmuch as one of the new divisions of work that has been inaugurated here at the University for the past two years has been known as University Extension work. If there is any line of University extension work that I believe will do good, there is no line of University extension work that will do more good than that which the University is trying to do in connection with public roads. In holding the institute here at the University I think we have chosen as good a place as we could possibly find, because here we not only come in touch and bring together those who are interested in actual construction of the public roads, but we call to the attention of something over a thousand young men who are to become citizens of North Carolina that the public road question is of vital importance to the development of North Carolina.

Before we begin the regular lectures and discussions I wish to speak briefly in regard to the purposes of the Institute. My idea of the Institute has changed but very little from what it was last year, and I can sum up in just a few words my idea as to the purpose of the institute, and that is—that it shall be made a clearing house for road problems in North Carolina. That will take up every single phase of road work, and it is up to us, as President Graham has said, to work out and solve the problem—because if we do not do it, I know of no one else who is going to do it for the State of North Carolina. We come here as a group of men who are particularly interested in construction work. I am very glad to be able to say that we have with us those who are not as interested as we are, from the engineering standpoint, but are interested from the contractor's standpoint and from the manufacturer's standpoint of road supplies. We are not going to obtain the best results of road work until we reach that time when there is a just and fair working basis between those who have charge of the road construction work in North Carolina, and those who are supplying the materials with which that work shall be done. I hope, through the Institute, that we can become

acquainted not only with each other in the construction work, but acquainted with those who are in the end to furnish to us the materials with which we are to build our roads.

Now, in working out the program for this meeting it seemed, on account of the hard winter that we have just gone through, that perhaps we should try to emphasize more particularly this year the type of road which, notwithstanding the serious comments made in the newspapers, is bound to be the chief road in North Carolina for many years; i. e., the sand-clay, topsoil or gravel road. You will notice, therefore, in the program which has been distributed, that we have worked out a program that starts in with the first step in road construction work, location, and this afternoon we will discuss the question of the location, design and construction of roads. Then we take up in general the surfacing materials of the sand-clay, topsoil and gravel roads in which North Carolina is particularly interested; then we take up methods of construction and follow that through tomorrow morning and part of the afternoon. We go briefly into the question of macadam roads, for the reason that this question has come up in several counties: What shall we do with the wornout macadam road? Shall we try to repair that with water-bound or bituminous material, or shall we put sand-clay or gravel on it?

On Thursday we take up the question of maintenance of roads, and, particularly, of the sand-clay, topsoil and gravel. Then we take up a phase of work that is leading right on to the question of maintenance, because on it depends largely the reason why so many roads have gone to pieces during the past winter; i. e., the question of drainage. After this we hope to make the culvert question a most interesting discussion on Thursday afternoon—terra cotta, concrete, corrugated and cast iron—both from the engineer's and the manufacturer's standpoint. On Friday morning we will have a discussion of blasting materials; also of the relations that should exist between the State highway commission, county highway commission, and township highway commission, together with relations of highway engineers to these; and we close at noon with a business meeting. Three important questions will come up at that meeting: How to improve the Institute; correspondence courses: are they of value?; and plan of coöperation for the employment of engineers, superintendents and foremen. Can we arrange in connection with the correspondence courses offered here at the University a satisfactory course connected with the road problems of the State that the engineers, superintendents and foremen can take to advantage? I want to get the engineers, superintendents and foremen of road work in North Carolina in such close touch with each other that we can know where the good men are and, as they finish one piece of work, there is no question about transferring them to another section of the State or county to take up a similar line of work.

Last year we carried out a program which seemed to give pretty satisfactory results, at least to the extent that a resolution was passed asking that the Institute be made a permanent thing. All the papers and lectures which will be given at this Institute will be open for discussion; and we have tried to arrange so that there will be plenty of time for the discussion of papers that come up. All are free to ask questions, and everybody is at liberty to ask to be helped out. That will give a little idea of what we are going to try to make the Institute this year. We take up this afternoon the location, designing and construction of roads. The first paper will be given by Professor T. F. Hickerson, Associate Professor in the Department of Civil Engineering of the University of North Carolina.

In the following pages are given the papers presented at the Institute and discussions of these papers (in so far as the stenographer was able to report them):

Considerations Governing the Proper Location of Roads

By T. F. HICKERSON,

Associate Professor of Civil Engineering, University of North Carolina.

Good roads are intended primarily to supply means of communication and transportation from place to place with a minimum of effort and resistance and in the least possible time. The highest aim of roadmaking, we may say, is "endeavoring to help make smooth the paths of humanity."

There are mainly *three* things which make a *bad road*; *steep grades*, *bad curves*, and *uneven surfaces*; the first two of which are permanent obstacles to traffic due entirely to a *bad location* of the road. The first and most important step in the road improvement in this State, as well as in the South, is to correct the mistakes made by our ancestors and relocate the roads so well that future generations will never see fit to make any radical changes. Evidently the location of roads should be governed by engineering principles.

There are really a great many considerations which exert an influence on the location of roads, whether it be a revision of any existing road, or the layout of an entirely new route. The first considerations are *line* and *grade*, but they are influenced more or less by drainage, annual cost, exposure to the sun, character of the foundation soil, best stream and ridge crossings, traffic conditions, serviceability to the community, esthetics, right of way privileges, etc.

ALIGNMENT.

It is desirable of course to make a road between two points as direct and short as possible, but a deviation of a few hundred feet from the direct line in order to avoid a hill or a swamp may not increase the distance materially. Thus, Fig. 1, if a due east line $AB=2$ miles in length and C is a point 1,000 feet north of the middle of AB , then the distance ACB is only about 190 feet more than AB . See Fig. 1.

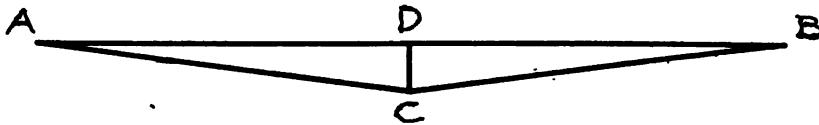


Fig 1

A slight curvature adds to the esthetic appearance of roads, but sharp curves are positively dangerous for modern traffic. New York State has adopted a minimum radius of 200 feet, wherever possible, with the result that the increased comfort has greatly pleased the traveling public. At the International Road Congress in London in 1913, it was agreed that the minimum radii of curves in roads used by fast traffic should, where practicable, provide an unobstructed view of 300 feet ahead, and where this is impossible, the curve being of too short a radius, means should be provided whereby the approach thereto is in some way clearly indicated.

In flat country, the controlling factor in the relocation of old roads is usually better alignment, that is, substituting smooth curves and tangents for sharp turns and zigzags, and at the same time, keeping on ground equally as good or better for grade and drainage. See Fig. 2.

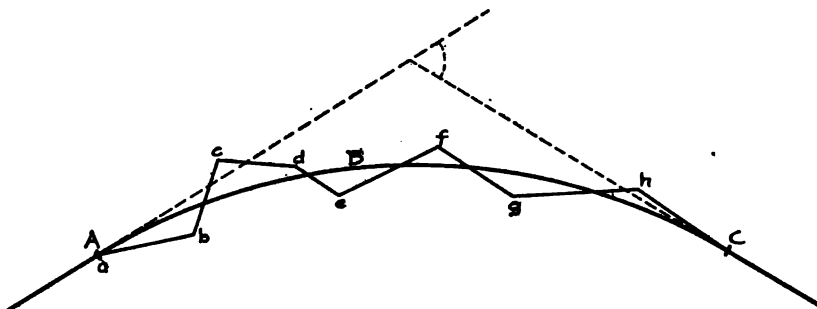


FIG 2

Thus, in Fig. 2, assuming that everything else remains the same, the long curve ABC may be substituted for the irregular line abcdefg of an old road which was originally laid out more or less by accident. Obviously it would be an unwise expenditure of money to build a sand-clay or macadam surface on such a road until the alignment is revised; yet there are too many cases where the public would say "let good enough alone" and attempt to improve the road surface which sooner or later will be abandoned when, say, the trees are all removed and the bad alignment is seen throughout just as an engineer would previously have seen it on a map.

GRADES.

In hilly and mountainous country, grades are the first consideration in road location. *Distance* must be sacrificed for grades. Formerly, very little attention was given to grades. Directness was the only consideration. Roads were located up and down hills when they might have been built around the hill with very little, if any more, first cost, and with a tremendous saving in the cost of transportation and maintenance. It is highly desirable that no grade shall be more than 4 per cent. As the grade increases beyond 4 per cent., transportation becomes burdensome and the erosion of the soil due to the increased velocity of surface water, begins to show marks of destruction.

Motor cars will pull heavy grades more easily than vehicles generally, and if it were not for the destructive effects of water, the matter of grade reduction would be less important.

DRAINAGE.

Drainage is the most important word in the road builder's vocabulary because it must be considered in connection with every phase of road building, be it location, construction, or maintenance. On account of better drainage, a ridge or even a side-hill location is preferable to a valley location. See Fig. 3, p. 19.

Too many roads have been located along the line of least resistance up the center of ravines until the head of the ravines is reached, and then up a heavy grade to the summit of a ridge. Fig. 3 shows how the location might

be improved by using a *side-hill location*, with better drainage and with a gradual upgrade to the summit of the ridge. The "valley route" would always be subject to the destructive effects of surface, as well as underground water, and therefore the maintenance cost (including repairs for bridges)

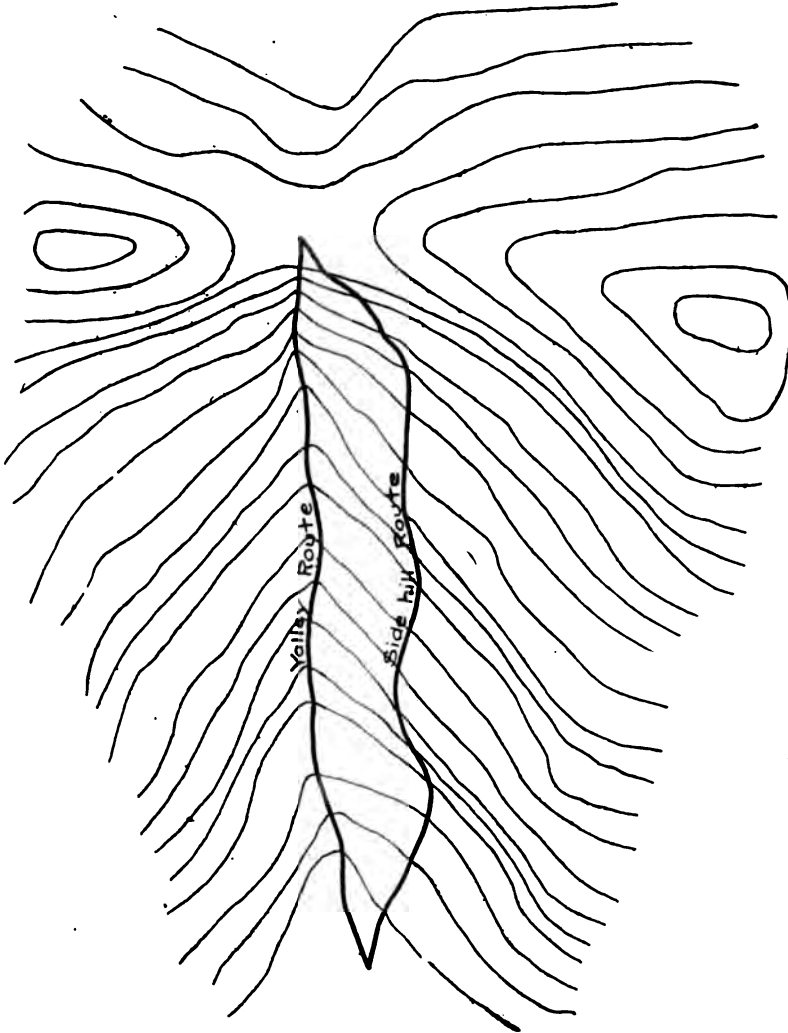


FIG 3

would be excessive. The "side-hill route," although slightly longer and perhaps more expensive in the first cost, has the advantage of remaining in good shape with comparatively little maintenance.

ANNUAL COST.

In considering the relative merits of two feasible routes for a road, the estimated *annual cost*, instead of merely the first cost, should be used as a

basis of comparison. The annual cost embraces the following items: (1) Annual interest on the first cost; (2) Annual cost of maintenance; (3) Annual cost of transportation; (4) Sinking fund for future repairs; (5) Sinking fund for extinguishing the original expenditure in a specified number of years.

The following illustration is an actual case that came within the experience of the writer:

Route No. 1 (see Fig. 4) follows an existing road which needs very little revision, but a river must be crossed twice and two 100'-span bridges will be necessary.

Length=3,500 feet.

Route No. 2 avoids the river crossings, but must cross over 400 feet of solid rock and then encounter side-hill construction and, finally, pass through the middle of a valuable farm.

Length 3,740 feet.

Route No. 1.

Cost bridges (life 30 years)	\$2,200
Cost abutments	1,000
Cost constructing road	500
Cost surfacing	300
	<hr/>
	\$4,000

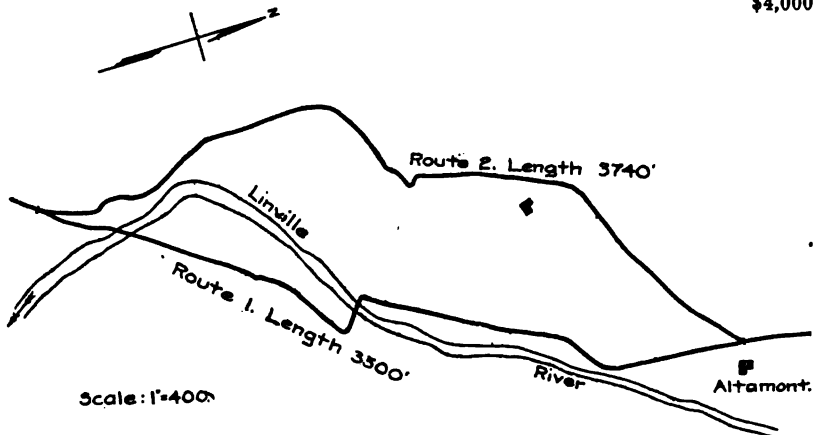


FIG 4

Route No. 2.

Cost construction	\$4,400
Cost right of way	100
Cost surfacing	400
	<hr/>
	\$4,900

Annual Cost of Route No. 1.

Interest on first cost at 5 per cent	\$200
Maintenance of road and bridges	100
Sinking fund for renewing bridges at 4 per cent	40
Insurance against destruction by flood 1 per cent	40
	<hr/>
	\$380

Annual Cost of Route No. 2.

Interest on first cost at 5 per cent.....	\$245
Maintenance	50
Cost of assumed transportation of 10 tons per day over 240' at $12\frac{1}{2}c$ per ton per mile	20
	<hr/>
Hence Route 2 should be chosen.	\$315

MISCELLANEOUS CONSIDERATIONS.

A sunny exposure and a porous foundation soil are highly desirable in order that the top and bottom of the road surface may be as dry as possible.

High stream crossings and lowest ridge crossings are often controlling points in the location of roads.

The traffic census of the road that is to be located and its relation to the road system has more or less influence in the location and a great deal of influence in the design of the road.

The location of a trunk line is not apt to be affected by local conditions other than topography.

Figure 5 shows the amount of territory that may be served by a highway between two cities, A and B, assuming that transportation on the minor roads costs twice as much as that on the main highway. Any road within this territory should be located at right angles to the main highway, AB, instead of straight towards A or B. See Fig. 5.

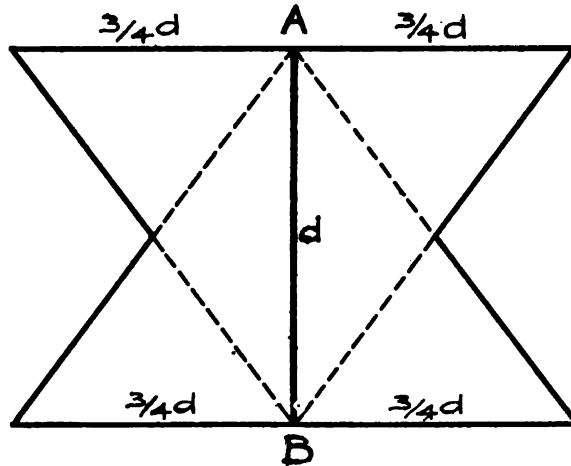


FIG 5

In locating certain roads, the question of serviceability to the local community must be considered carefully, but none of the technical requirements of a good road should ever be sacrificed. The following case will serve as an illustration of this point:

Between Snow Camp and Graham, N. C., is a long ridge which offers an ideal location for drainage, grade, and directness, but it would pass through an uninhabited territory and could not be reached easily by lateral roads.

The existing route, which admits of proper revision, leaves the ridge and passes through an inhabited territory. Evidently it is wise to relocate the old road, although it is not so ideal from an engineering point of view as the ridge route.

In conclusion, I should like to emphasize the fact that the location is the only *permanent* feature of road building and, therefore, it must receive careful consideration and foresight and preliminary investigations in order to satisfy *present*, as well as, *future* traffic requirements.

DISCUSSION.

MR. PRATT: One word in regard to the general problem of location brought out by Mr. Hickerson. The location is the only portion of your road in connection with construction that can in any way be spoken of as permanent, and for that reason, perhaps, as much as anything else, an engineer should be extremely careful that when he has made his report on the location of any particular road he has made the location that will not have to be changed in the future. In many instances there is a great deal of pressure brought to bear upon engineers, commissioners and superintendents in regard to the location of roads. I think the best illustration of the impracticability of deciding ahead of time where a road is to go is a bill that was passed some ten years ago by the General Assembly of North Carolina, in which the Legislature located a road in Mitchell County and stated that it should begin at a certain point. This was ten years ago; and that road has never been built.

Now, the personal consideration must not enter into road location. It is sometimes extremely hard to be entirely honest in locating roads, and probably there is no one who finds that consideration harder to overcome than the boards of commissioners, whether county or road commissioners, and it is the engineer who stands between them and the people. When a board of road or county commissioners has employed an engineer to look after the location of the roads over which they have control, the engineer must be the one to decide in regard to the location.

Now, we have had considerable trouble in several counties in regard to the question of location. I have simply told the engineer to make his report to his board and see that this report goes on record. The Attorney General has given an opinion that when an engineer is employed by a county to be in charge of road work he can insist that the report he makes shall go down on the records of the Commission; so that if there is any change made by the Commission in the location submitted by the road engineer it will have to show on the records of that Commission.

Now, as I have said, the location is the only permanent part of a road. The minute we begin to let the personal consideration affect that location or influence that location, we are not going to get the best location for the road.

I will speak a moment or two in regard to bond issues. The present General Assembly has passed already, I suppose, eight or ten county bills, some of which authorize an election for bonds, some instructing and directing the commissioners to issue the bonds for townships or districts, altogether something like nearly a million dollars worth of bonds being authorized already. The larger proportion of bonds are what are called long-lived bonds, running from thirty to forty years. To my mind such a bond issue in road construction should be used just as largely as possible in that part of the road which

we speak of as the permanent part of the road. Now, you have seen in the papers and road publications, some from the United States Office of Public Roads, information in regard to long-lived bonds, saying we ought not to issue road bonds for a longer period than the life of the road. Now the life of any road, so far as it depends upon the surfacing material, is probably just a few days after the time the road is built; because there is no type of road that does not have to be maintained. The surfacing material has to be repaired almost as soon as it is done. Take for instance, Fayetteville Street in Raleigh—this, representing the finest pavement, has to be repaired. In North Carolina, it would be impossible in many of our counties to issue for road work short period bonds; that is, bonds that would mature in ten or fifteen years, because the extra per cent that would be necessary to take care of a sinking fund and interest would require just the extra per cent to raise by tax that the people would consider impracticable. For instance, in this county (Orange) our bonds, consisting of \$250,000, run for forty years. We are taxing ourselves thirty-five cents on the \$100 worth of property to take care of these bonds. You cut that bond issue down to a fifteen-year bond issue and you would have to run your tax up considerably over thirty cents, so much over that you would not be able to carry the bond issue in Orange County. We did carry it with the expectation of running the tax up to 35 cents on the \$100 worth of property. With that idea in view—of the long-lived bond—I believe that just as much should be put in good location or the permanent part of the road, and that includes culverts and bridges, as possible. Therefore, when we consider all this, we can readily see that it is doubly important that the location shall be made permanent.

Economical Methods of Moving Rock

By W. S. FALLIS, Road Engineer.

In any discussion of methods of moving rock in road or other construction work, the local conditions must receive due consideration. What I am going to say is intended to apply especially to the conditions I have found existing in our State, and to the class of work that is needed on the roads in the sections of the State where rock is most frequently encountered. Some of the things which I shall define as economical under these conditions, could not be considered good practice under other circumstances, or in the case of larger operations.

In all rock work, no matter how it is prosecuted, the most expensive item of work is the drilling required to prepare the rock for blasting. There are several ways of drilling the holes for this purpose in common use. The two most distinctive are hand and power drilling. Drilling holes by hand may be done in several ways: (1) by hand-hammer drill; (2) by the churn drill; (3) by the rotary or auger drill. The last named drill is used only in very soft rock or coal.

The hand-hammer drill is the most commonly used of the hand drills. This drill consists of a piece of tool steel, usually hexagon but sometimes round in sections, from three-quarters to one and one-quarter inches in diameter and from three to ten feet in length. A bit of cutting edge is formed on one end somewhat broader than the diameter of the steel and a head for driving is made by annealing the other end. The bit is then carefully tempered to suit the kind of rock to be drilled. Different lengths of drills are used,

as the hole is deepened, for the convenience of the drivers. The operation of drilling is carried on by from two to four men, one man holding and manipulating the drill and from one to three men driving. Seven to ten pound (usually eight pound) "striking" hammers are used for this purpose. The handles of these hammers are made of the best hickory and should be very slender to secure the best results. Ten to fifteen feet of hole drilled per day of ten hours is about the average, according to the density or hardness of the rock. Eight feet is the usual limit in depth for a single hole, as the weight of the drill is too great for the man holding it to properly manipulate it for deeper holes. Experience has proven to me that three men, at one dollar and fifty cents per day, allowing fifty cents per day for sharpening and maintaining the drills, will drill blasting or bore holes in limestone or other similar soft rock for about thirty-five cents per foot of hole; or in granite or other hard and dense rock the cost will be about fifty cents per foot of hole. This is perhaps as good economy as can be obtained by the hand drill. Three well trained men form the most efficient gang for this work.

The churn drill is considered by some to be more economical than the hammer drill, and this is theoretically true, because the heat units lost between the head of the drill and the hammer in using the hammer drill are not lost in the use of the churn drill. However this may be, in practice the chief advantage of the churn drill over the hammer drill lies in the fact that deeper holes can be drilled with it than is possible with the hammer drill. Holes up to thirty feet deep are often made with the churn drill, and even deeper holes are possible. These drills when used for shallow holes are formed like the hammer drill, but have balls of iron or steel welded to them in order to give them sufficient weight to make them effective. In operating these drills they are simply raised and dropped by the men using them, the weight of the drill doing the work of cutting the hole. It is in very common use on railroad and other heavy rock work.

The chief object of this discussion is to call your attention to the amount of money that is so often wasted by the careless or ignorant prosecution of road work, when a considerable quantity of rock work is to be done, and to show that, by the use of proper methods, a large portion of this money could be saved.

The most economical method of drilling holes for rock work is undoubtedly by the use of some form of power drill. The steam drill, the air drill, the electric drill, the gasoline-air drill and the gasoline drill are among the many forms of power drills now on the market; and, under the various conditions of rock excavation, all of them have fields where they can demonstrate their economy. The air drill requires a somewhat expensive air compressing equipment and is often troublesome and expensive to move from place to place. The electric drill is practicable where current can be obtained. The gasoline-air drill is expensive and the gasoline drill still has some of the troublesome traits that distinguished the gasoline engine a few years ago. The steam drill, for the work most frequently met with in road construction, will, I believe, be found the most economical and satisfactory. This is largely on account of the small first cost of the equipment, and its equal efficiency when compared with other forms of power drills. A very good outfit, consisting of a drilling machine, hose and connections, drilling steels and sharpening tools, can be purchased for about four hundred dollars. If the county or contractor does not already own one, a suitable boiler can be rented at a nominal

cost. The drilling machine should be the size known as a three or three and one-eighth. This designation denotes in inches the diameter of the steam cylinder of the machine. This machine will drill from sixty to seventy feet of hole per day of ten hours, when properly handled, and at a cost of from sixteen to twenty cents per foot of hole, according to the kind of rock.

Comparing this with the cost of work by the hammer or churn drill, the economy of the power drill is at once apparent. The constant use of this drill for twenty-three days will pay back the purchase price, when compared with the cost by hammer drill, if the difference is only thirty cents per foot of hole. Experience has proven this to my complete satisfaction.

The following estimate will give a fair illustration of the economy of the power drill, when skilfully handled, as compared with cost by hammer drilling. In order that the estimated cost shall be entirely feasible and well within my own experience I will state a case that will produce a minimum amount of rock for the holing and powder used.

Assuming that we are working a quarry or lift of eight feet on open cut (not trench work) and the holes are spaced five feet from the face of the bench and five feet apart, this should give about one cubic yard of rock to each foot of hole. Assuming that the cost by steam drill is twenty cents per foot of hole or per foot of rock moved, that four cents will pay for the dynamite and that it will cost fifteen cents to haul to the dump each cubic yard of rock blasted, the total cost per cubic yard would be thirty-nine cents. Assuming again that the cost of drilling by hammer drill is fifty cents per foot of hole or fifty cents per cubic yard of rock moved, that four cents will pay for the dynamite, and that it will cost fifteen cents to move the rock to the dump, the total cost will be sixty-nine cents per cubic yard of rock moved. This shows a difference of thirty cents in favor of the steam drill for each cubic yard of rock handled. Since at thirty cents per cubic yard one thousand five hundred cubic yards would amount to four hundred and fifty dollars, I would advise any one to invest in a steam drilling outfit when there is any probability of having this amount of rock to move. The outfit would be more than paid for on the completion of this amount of work, and its value at the time would represent that much saved to the owner.

In preparing to load the holes for blasting, it is sometimes necessary to "spring" the holes. This is seldom required except in heavy work and is caused by the need for more space for the charge of explosives required. This enlargement or "springing" of the hole is accomplished by charging the hole with a small charge of dynamite and exploding same without ramming or packing of any kind. These holes are usually loaded with a combination charge of dynamite and black powder. In road and other light work, dynamite is generally used alone.

In selecting explosives for road work I would recommend that dynamite designated as "forty per cent" be selected and used exclusively. This grade of dynamite is of ample power for the work and is much safer in the hands of the inexperienced, and in fact in the hands of any one, than the grades containing a greater percentage of nitro-glycerine, and is perhaps the best all round powder for general use.

Dynamite freezes at a comparatively high temperature and, when frozen or even partially frozen, will not give good results. It is better to keep it from freezing than to have to thaw it out, but if frozen, great care should be taken in thawing. The use of fresh stable manure for this purpose, or a

double boiler using water at from ninety to ninety-five degrees (but no warmer) for filling the outside vessel is recommended. Never attempt to thaw dynamite before an open or any kind of fire.

The quantity of dynamite required for various kinds of rock and used under various conditions cannot be exactly stated and the amount of loading must be left to the judgment of the man in charge. It has been found, however, that in open cut work the charge need rarely exceed one-third of a pound to the foot of hole.

In firing the blasts there are two methods in common use, the "safety fuse" and the "electric blasting machine." The safest, and at the same time most economical method of exploding the blast is by the use of the electric blasting machine. This method gives complete control of the amount of explosion, saves the time of the men waiting for the fuse to burn, and makes "delayed" explosions impossible. An electric blasting machine capable of firing from ten to twenty holes simultaneously can be bought for from twenty-five to thirty dollars, including the required lead wire. Without considering the large element of danger thus eliminated, the economy of time required, as compared with the fuse method, will justify the cost of the equipment many times over.

The conditions surrounding the use of explosives are so varied that the best results can only be obtained by one who is thoroughly experienced in this work, and I would earnestly recommend that such a man always be put in charge of blasting operations when any considerable amount of work is to be done.

Hauling the rock after blasting is another element within the province of this question. The average distance necessary to move rock in road work is seldom more than one hundred and fifty feet from the point where it is blasted. I have found the old and familiar one-horse dump cart to be the best and most economical method of handling this part of the work. The reason for this is two-fold; the ease and rapidity with which it can be dumped and the facility and speed with which it can be replaced for loading. No other means for handling this material can be so easily put at just the right place for loading or so quickly emptied at just the right point. The cost of moving rock by this method can be described as follows: Two carts with two horses or mules will cost about two dollars and fifty cents per day, five loaders, one driver, and one dumper each costing one dollar and twenty-five cents per day, making a total cost of eleven dollars and twenty-five cents per day. Five loaders will load one-half cubic yard of rock in a cart in about four minutes. Allowing one minute to travel to the dump (a distance of from fifty to one hundred and fifty feet), one minute to dump and one minute to return and get into place for loading makes eight minutes for a round trip for each cart. This keeps the loaders busy, the driver busy, and the dump man, with perhaps only a small margin of time to spare. Moving one-half cubic yard of rock every four minutes will mean seventy-five cubic yards moved per day, which makes the cost of this part of the work fifteen cents per cubic yard.

In moving rock from macadam work or other construction work where the haul is long, say from one to four miles, an entirely different condition confronts us, and an altogether different method must be employed. During the construction of the macadam road work in Wilson County in this State, I found that a maximum haul of seven miles would be required. This was

prior to the development of the many efficient hauling outfits that are now on the market. This work was done under contract, by the use of mules and wagons. The wagons were built by the Hackney Wagon Company of Wilson especially for this work and were of eight thousand pounds rated capacity. The bodies of these wagons were of the "stick" variety, and held three cubic yards. These wagons were loaded with an average load of four tons of crushed rock, and four large mules handled them very readily. The hauls under this contract were from one to four miles in length and the cost of the work was eighteen cents per ton mile. This paid the contractor about six dollars per day for his team of four mules and driver. The loads were dumped into the wagons from the crushed bins, and unloaded by removing the slats of the "stick" body. The time consumed in loading did not figure largely in the cost of the work owing to the length of the hauls.

In an article published in October issue of *Better Roads* in behalf of the Troy Wagon Company, of Troy, N. Y., there is made, in tabulated form, a statement from which the following is taken: "A motor truck test shows that, for the distance given in the Wilson work, this truck hauled stone at a cost of twenty-five cents per ton mile. With one trailer truck the cost was fifteen cents per ton mile, and with two trailers the cost was reduced to thirteen cents per ton mile." In considering the economy of the use of motor trucks for hauling material there are many things that should receive attention. Among these I will mention only one as being especially worthy of the attention of the road builders here, and that is, the destructive effect on our roads of the heavy weight on the rear wheels of the motor truck. Will the damage thus done to the roads be equalized or overcome by any economy in the use of the truck? In my opinion the medium or light weight tractor, with the load weights divided up among several trailer trucks, will soon demonstrate that it is a much more economical means of hauling material than the motor truck or heavy tractor now in use on many roads. I believe that this will certainly prove true when we give due consideration to the maintenance of our roads. I am quite sure that as an investment a medium or light weight tractor will be a more efficient tool than the heavy machines now on the market, for the various purposes to which it could be applied in road construction and maintenance.

Economical Method of Handling Surfacing Materials in Road Construction

By R. P. CORLE, Road Engineer.

The most essential thing in the determination of results from the use of any particular method of handling surfacing materials, is the efficient application of the method, based upon practical and economic principles. Probably there is no one best method for any given set of conditions, or one method applied to one condition economically could not be so applied to another. Therefore, it is the first duty of the highway official to study carefully the various methods and the nature of the conditions to which they are to be applied. In doing so he must consider the type of equipment coincident with each particular method, whether hauling is done with wheel scrapers or with wagons, with traction outfit or with motor truck, and the application of each of these to the different local conditions to which they may be subjected.

The cost of hauling may then be determined by the various factors involved, for any given piece of work, and the economy of the different methods compared.

1. Cost of operating the outfit, including interest on investment, depreciation by wear, maintenance and supplies, such as repairs, fuel, oil, etc., and labor necessary to operate it.

2. The amount of tonnage, or capacity of the outfit per trip.

3. Speed of the outfit used, or rate of travel.

4. The length of haul, or distance of the material from point of application.

5. The amount of time lost while loading and unloading, and also time lost due to the condition of the roads over which the hauling is done.

The industrial railway might also be considered here, but since the items of equipment previously mentioned are the ones largely used in road construction, especially in the Southern States, are all that will be considered in the scope of this paper. Average conditions should also be implied, as the cost of operation of any machine should be taken from the average of many runs under normal conditions and not from exceptional runs made under the most favorable conditions, such as conditions of water, roads to be hauled over, and the general efficiency exercised in operating. All of these various conditions tend to decrease the efficiency of the outfit in the proportion to which they are applied, and vice versa.

The materials used in surfacing will also determine to some extent the type of equipment or method to be employed. We could not use wheel scrapers with economy in macadam surfacing, while, I believe it will be generally acknowledged that wheel scrapers are the most economical when gravel or sand-clay is used, and the length of haul does not exceed a thousand or twelve hundred feet: (1) because they are easy to load and unload; (2) because the surfacing material can be more evenly applied by this method than by wagons, motor trucks, or traction outfit; (3) because this equipment is necessary in grading and is generally on the job. Hence it is economy from the standpoint of adaptability to various classes of work. While other methods might be employed for the haul of twelve hundred feet producing more efficiency, yet, to employ these methods would necessitate the purchasing of another outfit, and the outlay of more money in equipment, without knowing, possibly, where it would be employed next. For that reason it is more economical to use a reasonably efficient method continuously rather than a special and highly efficient one for a certain kind of work and have it idle for a large percentage of the time.

Considering the various factors previously mentioned and enumerated in the cost of hauling, the wheel scraper is especially applicable to at least two of them, low cost of operating, small amount of time lost in loading and unloading, which is indispensable for short hauls. It might also be added that for conditions as they exist especially in the South where the material for surfacing is obtained from the adjoining fields, and clay obtained from pits opened near the roadside, it is more nearly fitted to meet these conditions with lower cost than any other method for handling to be employed.

When the length of haul exceeds the limit for the wheel scraper other methods should be introduced, and the one producing the greater efficiency from the standpoint of first cost, output, etc., adopted. To ascertain this, it is necessary to compare the various methods for certain lengths of haul, and consider the varied factors making up the cost of hauling pertinent to each of these methods.

The cost of operation will vary as said before with conditions of the weather, roads, skill exercised in operating, the outlay for equipment plus

upkeep of same, the labor necessary to operate, including loading and unloading. While the values assigned can only be taken as closely approximate for average conditions, they will perhaps aid in comparing the cost of hauling in each method, and are as follows: Cost of teams when wagons are used, 60 cents per hour; for motor truck, \$2.75; for traction outfit, \$3.50.

The capacities of outfits also vary, but it is the aim to consider only those in common use as a basis for comparison; wagons for team hauling 1½ tons, motor truck 5 tons, traction outfit 15 tons.

The rate of travel is practically the same for all outfits of any particular types, though this varies somewhat with the condition of the roads, however, there is an average that may be taken as a value and meets generally the conditions as they exist; for teams three miles per hour, traction outfits three miles, motor trucks ten miles, assuming that half the distance is travel loaded and half unloaded.

The length of haul of course, is the same for any particular piece of work.

The amount of time lost depends entirely upon the methods used in loading and unloading the outfit. If the quantity of material at any particular place is sufficient to justify the use of a bin or trap for loading, or if extra cars of the equipment are loaded while others are on the road, very little time need be lost. The extra cars are a necessity especially in traction hauling, and unless these can be provided for, the traction outfit would not be a practical one to use. Any time lost while loading and unloading is very expensive and should be eliminated as much as possible. The following amounts of loss of time per trip will be nearly enough correct to get a comparison of results, and are as follows: For team hauling when shovels are used in loading, 15 minutes; motor trucks when loaded from bins or traps, 8 minutes; and traction outfits, 30 minutes.

Knowing the relative parts that enter into the cost of hauling and handling surfacing materials and the relation existing between them, the cost per ton may readily be computed from the following equation for any length of haul, and the results compared as follows:

$$*C = \frac{rd}{ns} + \frac{Tr}{n}$$

Where

$$C = \text{cost per ton for length of haul} = \frac{d}{2}$$

d = distance in miles per round trip.

n = number of tons hauled per trip.

s = speed of outfit in miles per hour.

t = time lost loading plus time lost unloading.

r = cost of operation in dollars per hour.

By inserting the values of the various factors making up the cost of hauling in the above equation for each method we get the unit cost by that method

for any length of haul — which are as follows:

$$C = 0.133d + 0.100, \text{ for team hauling.}$$

$$C = 0.055d + 0.073, \text{ for motor truck hauling.}$$

$$C = 0.077d + 0.116, \text{ for traction hauling.}$$

*This equation taken from abstract of paper in Engr. News by Prof. Agg. University, Illinois

By inserting the values of d and dividing these values by 2 for the length of haul in the three above equations, we get the following results, or cost per ton by the various methods, for the length of haul in question:

	Half mile.	One mile.	Two miles.	Three miles.	Four miles.	Five miles.
Team hauling	\$0.166	\$0.233	\$0.366	\$0.499	\$0.632	\$0.765
Motor hauling .....	.101	.128	.183	.238	.293	.348
Traction hauling .....	.155	.193	.270	.347	.424	.501

The above values are computed for comparing the cost of handling materials by the three methods mentioned above, and while some of them were taken in the field and are nearly correct under the conditions the outfit was working at the time, others were assigned from the best available data at hand. If the values inserted in the above equations are not applicable to a given set of conditions, others can be taken that are fitted and computations made for comparisons, in determining the most economical method to employ for the conditions being dealt with.

An experienced man must be put in charge of either method employed if satisfactory results are to be obtained. This will apply just as forcibly to the team method as to the motor truck or traction. He should be a man that can quickly grasp and solve any problem that is liable to occur in hauling, such as delays due to some part of the outfit being impaired, or other unavoidable causes resulting in delays. In team work the teams should be kept so regulated on the road, as not to have more than one team loading or unloading at the same time. The idea is to get the greatest efficiency from minimum cost. To do this, just a sufficient number of teams should be employed to keep the loaders loading continuously, and no more. Time lost by wagons waiting at the borrow pit to be loaded is money lost, and should not be tolerated. No given set of rules can be handed out to meet all conditions as they occur in the field. For this reason the superintendent or foreman must rely upon his initiative to meet the conditions as he finds them.

No one of the methods mentioned in this paper is applicable to all the varied conditions as they exist, and while one cannot be used economically, another can. The one more nearly uniting all the requirements from standpoint of cost and results is the one that should be considered, and if found practical and well adapted to conditions as they occur, adopted.

The Effect of Grades Upon the Design and Location of Roads

By D. TUCKER BROWN,

Road Engineer and Director of North Carolina Good Roads Association.

Any point in the center line of a road is determined by its horizontal and vertical position with reference to some fixed or starting point. The first, or horizontal position is determined by the alignment, and the second, or vertical position is determined by the grade. It is therefore possible to alter the center line of any road so that it will meet the conditions imposed by any change of alignment or grade, and any change in the alignment or grade will necessarily alter the center line.

It is the effect which any grade or change of grade might have on the final location of a road, considered from a point of economy, that I will discuss; but before doing so, wish to review briefly the costs attached to roads, in order that I may more clearly show how each of these costs is affected.

Roads, as do any other from of construction, represent an expenditure of money, either by an individual, a corporation, or the public; the capital necessary, depending entirely upon the execution of the work, and the requirements of the plans and specifications. It matters not in a completed road what the cost of construction was. All that is left to represent the money invested is the road itself, and it is the care to be taken, and the use to be made of this, that determines whether or not the investment has been made wisely or unwisely. The construction is accomplished by various methods; it makes no difference which, some one has to "foot the bills."

It has been frequently said, and too often I think, that money has been wasted in the construction of roads. Whether that be the case or not, the proper course to pursue after the road is finished is one of vigilance and perseverance, in order to protect that which has been invested. The only way that this can be done is by an adequate and efficient system of maintenance, for the only source on public roads, (other than a direct tax), from which the interest on the cost of construction and cost of maintenance can be paid, is the money which is indirectly saved the public, by the difference in the costs of transportation over improved and unimproved roads.

The cost of transportation depends upon the costs of construction and maintenance, but when maintenance is necessary, construction has ceased, and if the maintenance is neglected, the only source of revenue, (indirect as it may be), is immediately throttled, and the road becomes a burden, to be borne by the taxpayer, out of a pocket which is not being replenished by the same agent which is emptying it.

On most roads a pretense at maintenance is made during certain seasons of the year, and this, frequently, if not always, costs more than a system of maintenance that would bring good results and revenue. This accounts to my mind for the cry, "money wasted in construction," and it is not remarkable that the public should be dissatisfied and aggravated, when they are paying directly, two taxes, the costs of construction and maintenance, and indirectly, the cost of transportation, which, instead of being a tax, should be a source of revenue made possible by improvements.

The locating and designing engineer has the problem of properly adjusting the costs of construction and maintenance, and consequently that of transportation, so that the road improved according to his plans will be a revenue producer. It is the effect which grades have on these costs that I shall consider.

As has been said before, grade is one factor upon which the final location of a road directly depends, and it has a more subtle effect upon the costs than does alignment. It is an easy matter for any one to see that time is being lost when he is traveling two miles to reach a point one mile away, but it is not so easy to understand the difference in the cost of moving a load up a two per cent and a six per cent grade.

EFFECT OF GRADE UPON THE COST OF CONSTRUCTION.

The cost of construction may be divided into three separate and distinct costs, the cost of drainage structures, the cost of roadbed, and the cost of the surface, all of which are more or less dependent upon grade.

DRAINAGE STRUCTURES.

The design of drainage structures is governed largely by the difference in elevation of the grade line, and the original surface of the earth at the point

where the structures are to be used, consequently their cost varies with any and every change of grade. There is no method of determining in a general way the cost of a structure for any specified drainage area. Each stream crossing and drain should be taken care of by either a bridge, culvert, or pipe, the designing of which has been made to suit the conditions imposed. The properly located road will, therefore, cross streams and drains in a way that will permit the use of economical drainage structures.

ROADBED.

In the construction of any roadbed, the total yardage of material and the points to which and from which it is to be moved, are fixed by the alignment and grades, that have been established. The total cost of excavation is, therefore, directly dependent upon the alignment and grade, and it is affected most (properly located roads being considered) by grades in level country and by alignment in mountain country, for in practically level countries any change of alignment would require negligible changes in grade to obtain the same excavation as was necessary before the change; but in mountainous sections just the opposite is usually the case.

If grading is not properly done, grades may affect further the cost of the completed roadbed, for on new construction the embankment and exposed slopes are easily washed by running water; and if the grades are steep, the velocity of the water is materially increased and much damage may result unless the proper precautions are taken for getting rid of the water. After the road is complete, grass, honeysuckle, vines or some other growth will be a great protection to embankment and slopes.

SURFACE.

The cost of surfacing a road is dependent to a large extent upon the distance the surfacing material has to be hauled. A part of this distance is usually along the road upon which the material has to be deposited, and it is over this section that the cost of hauling is affected by the grade of the road under construction. It is much more economical to have the wagons loaded with surfacing material travel down grade or up slight grades, than to pull a part of a load up a steep incline. This is a transportation cost but, since it has to be paid out of the capital provided for the construction of the road, it is also a construction cost. Engineers should consider this when locating the surfacing material for the road.

EFFECT OF GRADES UPON MAINTENANCE.

The cost of maintenance like that of construction may be divided into three costs, the costs of maintaining drainage structures, roadbed, and surface.

DRAINAGE STRUCTURES.

The cost of maintaining drainage structures is not affected at all by the grades, *provided*, however, plans have been properly made and the structures built accordingly.

ROADBED.

The cost of maintaining the roadbed is dependent to a large extent, if not altogether, upon the action of water, which on steep and level grades is much more severe than on medium grades.

Water may be destructive either when in motion or at rest. It is moving water on steep grades, and water at rest on level grades, that has to be provided for. The deleterious effects of water may and should be foreseen and prevented to a large extent by the locating engineer.

The fact must never be lost sight of, that adequate drainage is always *necessary*, and must receive the locating engineer's first consideration. Steep grades, as do level grades, necessitate expensive drainage systems. The medium grades are therefore preferable.

The rain water which falls upon the surface of a road before it accumulates in the ditches has its effect upon the shoulders, and, if the grades are steep, the tendency is for the water to follow the road longitudinally instead of flowing to the ditches. This can be best prevented by maintaining the lateral grade (crown) of the road steeper than the longitudinal.

SURFACE.

The cost of maintenance of the surface of roads is greatly increased by any increase of grade, which is mainly due to the difficulty of keeping the crown always in a condition that will permit undisturbed drainage to the ditches. This is especially hard on steep grades, when it is realized that it requires much more tractive effort to move loads up grades than on a level. There is always a tendency for the surface material to become loosened and displaced by the constant "downhill pull" of the traffic, and, unless the surface is carefully watched and kept in place, water will begin to seep through and soften the sub-grade or foundation and eventually undermine the road.

EFFECT OF GRADES UPON TRANSPORTATION.

As mentioned before, the cost of transportation is of paramount importance, for it is the saving in this cost that provides the funds for paying the construction and maintenance costs.

There are at present two principal methods of transportation, by motor vehicles and by horse-drawn vehicles; and as they are so entirely unlike, and the effect which grades have upon the cost of each so different, it is essential that they be considered separately. As this paper deals only with the economical effect of grades, I shall not consider the transportation of pleasure vehicles as distinct from freight vehicles.

TRANSPORTATION BY MOTOR VEHICLES.

Motor vehicles can with apparent ease ascend a continuous grade of ten per cent, no matter how long it is. The only appreciable loss in going up grade is that due to the decreased speed, the additional amount of fuel consumed, the increased wear on tires, and the wear and tear on the engine. The loss due to the decreased speed is hardly worth considering, for most motor vehicles can carry their maximum load over any improved and hard surfaced road at the maximum speed allowed by law in most states.

The amount of fuel consumed in going up a grade, over and above that which would be used on a lesser grade, represents a loss due to excess grade; but if the grade of the road is undulating or sinous, a great deal of the fuel which would be lost can be saved by coasting down one hill and allowing the momentum so acquired to help propel the vehicle up the next. I am of

the opinion that it would take no more fuel to propel a motor vehicle over a road, the grade of which was as shown in A, than it would to propel it over a road the grade of which was as shown in B. See Fig. 6.

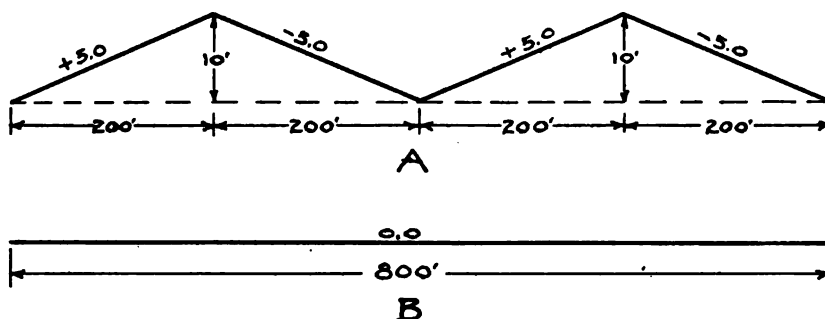


Fig. 6

Again the amount of fuel necessary to operate a motor up a 10 per cent grade, over and above that necessary to operate it on a level grade, is to some extent compensated for by the increased speed maintained on the level grade. This would be a total loss, however, if the speed up the 10 per cent grade were the maximum allowed by law and the motor driver were required to stay within the speed limit on light and level grades. The wear on tires due to pulling up heavy grades over that due to lesser grades, I think, can be considered practically in the same manner as fuel consumption.

There is one other effect of heavy grades on motor traffic, and that is the wear and tear on the engine, which I think should be negligible, provided the engine has been properly designed. I do not therefore believe that motor traffic is seriously affected by grades up to 10 per cent, provided they are not too long.

TRANSPORTATION BY HORSE-DRAWN VEHICLES.

This presents an entirely different problem from the cost of motor transportation. There is a limit to the amount of work a horse can do, and we are powerless to materially extend that limit. It is impossible for a horse to produce momentum in descending one grade that will assist him in climbing the next; in fact, there is a great deal of energy expended by a horse in descending grades, and especially steep grades, and if hastened down them permanent injury may result.

The maximum grade that can be economically used for horse-drawn vehicles is undoubtedly less than it is for motor-drawn, and therefore horse-drawn vehicles should receive first consideration by the engineer.

The maximum grade which it is economy to use for horse-drawn vehicles varies with the character of surfacing of the road, for the rolling resistance is dependent upon the surface, while the grade resistance is not. The best authorities give the maximum grade for earth roads as 7.5 per cent and for macadam at 2.2 per cent.

The only effect that grades have upon the cost of transportation by horse-drawn vehicles is due to reduced load, for the maximum load that can be hauled over a certain road, is the maximum load that can be hauled up the

steepest grade. This cost can be obtained in dollars and cents, but I do not consider that necessary, or within the province of this paper.

In conclusion, I will say that no engineer will regret it if he gives his undivided attention to the cost of grades before undertaking the construction of any road.

DISCUSSION.

MR. FALLIS.—In connection with that, in building or making these locations, it is a wise thing to get the location and build, finish and grade the road in such a way that if we intend to put a more valuable surface of bituminous macadam on it, there will be no necessity for further grade work. The original foundation is built with bond money. That is one thing I try to emphasize in my work.

MR. PRATT.—In many sections of North Carolina it is the traffic that should determine the surfacing material. As the traffic increases and demands a harder surface, there ought not to be any question that you have got to change the location, because you have not a foundation that will stand heavy traffic. That is one of the principles that should govern the location that we are building for the future. We all know that as the traffic increases and the demand for heavier surfacing material increases, there is never any trouble to find money with which to put down a heavier surfacing material, because increased traffic means increased wealth in the community.

MR. SPOON.—An idea occurred to me in relation to bond issue in road location. That is, since the location is the one permanent thing and since population increases, it is extremely wise when a bond issue is made, that as much as possible of the main system of a road be fixed permanently. The difficulty of getting a right location is daily increasing.

MR. PRATT.—This year I have had included in the local county bills introduced in the General Assembly that before any road work is done in new counties taking up road work, there shall be made a road survey of the county, to get the engineer and commissioners to become familiar with the county as a whole; determine the location of the people of the county, its topographic condition; the relations of its roads to those of the adjoining county, etc., so they will know what are going to be the main traveled highways. This includes not a complete traffic survey but a fair, comprehensive idea of what the particular county and those who have never considered that point will be surprised when you find the very high percentage of the traffic that goes over the very small percentage of roads in the county or township.

MR. PRATT.—One more point in connection with the location is the location of a road on the north or south side of a mountain. There is a difference in the cost of maintenance according to the side of a mountain or hill on which the road is located when the question of shade comes in. This has very little to do with the actual location problem but has a great deal to do with the question of maintenance of gravel, sand-clay or topsoil roads. We have tried to include in the bills a provision for a right-of-way which will permit the commissioners to cut back where they go through a wood a sufficient number of trees to permit sunlight to come in so that the road can be easily dried up.

Economical Methods of Moving Earth in Road Construction

By N. C. HUGHES, JR., Road Engineer.

In all classes of road construction there is ever one proposition that has to be dealt with: one so real that it easily may be termed the differential

which governs the ultimate cost of a completed highway. And this proposition is that of moving earth, better known in construction work as excavation. The natural consequent to this proposition therefore that should be sought is that of "The Economical Methods of Moving Earth in Road Construction"; and this is properly always considered from a yardage basis. So let us discuss briefly this subject, first from a view general, and then from one specific.

Generally speaking, the conditions attending earth work in the construction of highways vary considerably and are materially different in different localities. In the mountainous region, besides the rock problem, there is found an earth full of loose rock which cannot be classified as rock work, but is very heavy earth work, full also of gravels of varying sizes with a heavy, sticky red clay which offers a very tough resistance in being moved. In the Piedmont sections there is a combination of soils; a topsoil either of very coarse grit with some gravel, or of pure gravel or of clay-gravel, or pure gravel-clay quite stiff and lumpy when once loosened up, either as a top soil or subsoil excavation. There is found a stiff, bull-wax clay, or a buckshot clay under the top soil. In the tidewater sections the principal soils are, for the topsoils, sand-loam, pure loam, and pure sand, with now and then a pocket of grit so coarse that it might be called gravel; for the subsoil, a silty reddish clay or pipe clay, or a yellowish silt-clay. These varying classes of earth are here mentioned to show wherein the cost of moving them is of course bound to be more or less to a degree according to the location of the material.

Before going further, however, let us understand that all the figures appearing in this discussion are based upon a unit which bears the total expense of operating and maintaining an efficient outfit for grading, except where otherwise hereinafter specified; also upon the basis of a county or township owned and operated outfit, for under proper management it is undoubtedly cheaper to handle earth with such an outfit than it can be done by contract. Also with labor graded from \$3.50 for the superintendent or main foreman down to a dollar per day for the water boy; interest on the capital invested; allowance for deterioration of the equipment per month; and the current expenses attached to the whole operation.

To return to the subject of economics, before undertaking any great amount of excavation, it is best, (1) to investigate the surrounding conditions and the nature of the work and, (2) to figure about what amount of money may be legitimately allotted to this portion of the work to be undertaken. If the finances and the extent of the work will so justify, and where the excavation is quite heavy and frequent, in the end, no doubt, the economical thing would be the installation of an automatic steam shovel of at least a yard capacity and its accessories. It is possible under proper manipulation of the shovel and the team work to move earth for from five to seven cents per cubic yard, provided the haul does not exceed six hundred feet on an average; and with the shovel alone on excavation to be wasted, or on hillside cuts, it should be moved for from three to five cents per yard. While this outfit is apparently economical perhaps only on work requiring a removal of from five to eight thousand yards per mile or more, with at least a year's work to be done, to admit of the outlay for the installation, I believe still the time is not far distant when the road work throughout the State will reach such proportions as will not only justify but demand a very extensive use of the

steam shovel. But under present conditions, principally financial, it appears on the face of things to be out of the question to depend mainly upon a steam shovel for excavating purposes.

Granted therefore that we must of present necessity abandon any thought even of the general use of this machine in our present method of road construction, let us turn to other means more within reach of the funds provided therefor, and more adaptable to the conditions to be confronted and dealt with. Here again must conditions be thoroughly looked into, both those financially backing the project and the physical ones actually to be contended with.

Granted then, to be specific, that the finances are sound and sufficient, that there is an average per mile of two thousand yards or more of excavation necessary for required grade, with the material to be moved varying in classification from loose rock to sandy loam, so balanced as to give an average haul from cut to fill of five hundred feet, and one not over two hundred feet for waste. Under the above conditions, I should say, the most economical method of moving earth is by means of teams and wheelers. This being the case, it is proper to base calculations for the cost of moving earth on what the snatch team can do per day or per month, preferably per month, as this length of time will include the overhead. The proposition is to keep enough wheeler teams on the job to keep the snatch team busy loading one and almost immediately turning to load another, whether five or ten wheelers are required for such an operation; the longer the haul of course the more wheelers, about one to every additional one hundred feet beyond a five hundred feet free haul and up to one thousand feet free haul.

Where the excavation is continuous it is always economical to equip the outfit with a number one class of team as well as with a number one grade of machinery. Then, to go more into detail, the cheapest method of moving earth is by means of a 4-up snatch team loading wheelers of a size No. 2½ with carrying capacity of seventeen cubic feet. This outfit will move upon an average of eighty-five hundred to nine thousand yards per month, or twenty-four working days out of the thirty, at a cost per yard of from thirteen and a half to fourteen and a half cents; with convict force from ten to eleven cents. It is possible to move earth quite cheaply with a 3-up snatch team also, loading wheelers of size No. 2, with carrying capacity of from twelve to thirteen cubic feet. But since it is obvious that the 4-up team will move a third more earth than the 3-up team with but little additional monthly expense, the conclusion is that it is cheaper to be equipped with the heavier team and the heavier machinery. In passing this proposition let me say that no doubt the excessive cost at times of excavation in road work is due in a large degree to a lack of proper equipment. To be lacking one or two teams in the proper handling of earth work is a great deal more expensive than the overhead expense of carrying one or two teams for the purpose of running them in when needed.

There are conditions under which it is very economical to move earth with the ordinary drag scrapers of five to seven cubic feet or a Buck scraper carrying eight to ten cubic feet. But the work must be either a swap-over proposition or not have a haul of over two hundred and fifty feet, and too, the material must be rather light. Work of this character with these scrapers should easily be done for six to eight cents per cubic yard. Upon the whole, however, these instruments are merely adjuncts to the whole equipment and by no means sufficient alone for an excavation outfit.

We now come to the consideration of the use of the road machine or grader for excavating material. In case it is to remove rapidly the top of an old worn roadbed to a depth of four or five inches to be replaced by good surfacing material, where the location and conditions will at all permit, the cheapest operation on this is with a six- or eight-horse road machine. By this method, however, the material can be removed only to either side of the road. Under ordinary conditions this class of earth work can be done for from three to four cents per cubic yard. The road machine also does very economical work in cutting off bumps and filling in holes in the preparation of the sub-grade for the surfacing material, or, as it may be termed, scrape-excavation. The use of the road machine is also a very economical method in excavating hillside cuts either in half-way or two-thirds work, up to the point where the wheeler or the slip scraper comes in as the cheaper method for such removal. The same may be applied to mountain work of this class. Allotting to this operation its legitimate part of the burden of expense, earth can be moved by this method for some five or six cents per cubic yard under ordinary conditions. In this class of work, too, the Buck scraper will give very efficient service, moving earth for from eight to nine cents per cubic yard.

While moving the material for surfacing roadways is a form of excavation, it is in a class distinctly by itself, as we will soon be shown by one of our number present this afternoon. Still in road construction, general excavation and moving of surfacing material must of necessity be taken care of by a combination outfit, since they are interlocked to such an extent that one cannot be considered without the other.

Finally, let me say, that the personal equation plays perhaps the most important part in the economical method of moving earth. That is to say, it rests largely with the foreman or superintendent of a grading outfit as to how much or how little an outfit will move in the run of a month, which of course governs the cost of the yardage. As in any other work or business, the trained mind, or the mind with a natural bent for a certain work or a certain business, counts for economy or success; so too in road construction, and in the moving of earth, particularly, the trained mind, one with a foresight for the main chance to get ahead always is worth far more to the job than the cost of that skill will be an expense. One man can take the same outfit and under the same conditions move twice as much earth in a given time as another one can, by reason of his foresight and his skill as a manipulator of labor being far superior to that of the other. Organization first under a competent superintendent, then with a body of trained labor and team work, will better insure economy in moving earth of whatever nature than any other factor in the whole problem of road construction.

WEDNESDAY MORNING, FEBRUARY 24.

9 O'CLOCK.

MR. PRATT: Sand-clay, topsoil and gravel, classified together, all represent one type of road, inasmuch as the materials of which they are constructed consist of grains of sand, coarse pebbles and the cementing or binding material is some form of clay. So, they are classified together as one type of road, and the discussion this morning will be given

to this type of road, its construction, composition, etc., and this afternoon the first hour will be given to the examination of these road materials.

The discussion this morning of the sand-clay, topsoil and gravel roads will be opened by a man who is probably as familiar with this type of road as any man in the country. You know this type of road is peculiar to the South. Gravel roads have been used a great deal in the North, but when we speak of the sand-clay or topsoil roads, they are peculiar at the present time to the Southern States. Professor C. M. Strahan, of the University of Georgia, will make us a talk and lead the discussion on the question of "Sand-clay, Topsoil and Gravel Roads." I am very glad to have him here with us and to introduce him to you.

Sand-Clay, Top-Soil, and Gravel Roads

By C. M. STRAHAN,

Professor of Civil Engineering and Director of Good Roads Department of the University of Georgia.

If there is one thing which marks the community of interest of the Southern States more strongly than another, it is their common difficulties in solving the problem of adequate public roads. As a matter of fact, from the standpoint of importance and complexity, the road question is the largest common interest between all the states of this great country, and the quest for a large mileage of improved roads at low cost is the vital demand of every State and of every county that is awake to its future progress.

I have just come from the rich State of Michigan with its two hundred miles of \$15,000 concrete roads and its eight thousand miles of \$3,000 gravel roads, where they are earnestly asking what can be done with the seventy-five thousand miles of earth roads yet unimproved.

The problem is so large in every State that financially the first steps in road betterment must be limited to the low cost road; and it is difficult to see how a betterment expenditure above \$1,000 per mile can be widely available for many years to come for any considerable percentage of the 2,300,000 miles of public roads of the United States. The high priced road must remain the exception, and the low priced road the rule, in all extensive road programs.

Georgia and North Carolina have recognized this controlling fact, and have been working along very similar lines. The essence of their efforts has been to fully and completely utilize local materials in making the wearing surface of the road. Naturally and most largely, attention has been given to natural soils of sand-clay composition, to sub-surface beds of promising character discovered in grading, and to artificial mixtures of clay with sand, and of sand with clay according to the demands of the immediate soil on which the surface coat is to be built. We use the terms "top-soil roads," "semi-gravel roads," and "sand-clay roads," to describe the several types. By field experience and by laboratory examination of soils and mixtures used, we have come to know more about the behavior of these materials, and how to assure ourselves of adequate service in advance of construction. It is my privilege to go over with you the lines along which experience has led us, and to point out a proper conception as to how and why soils and mixtures of this class can be intelligently selected or compounded into efficient wearing coats.

Cost being the controlling factor, it is readily seen that natural soils and soil ingredients offer distinct economic advantages by virtue (1) of their abundance and cheapness, (2) of minimum haul, (3) of a physical state ready for easy loosening, transporting, mixing and shaping, and (4) by virtue of the minimum expense and maximum simplicity of the outfit for road building purposes. If we can add to these advantages the further qualities of prompt consolidation, of freedom from softening under wet weather, of reasonable smoothness with absence of deep mud or deep sand, and of good durability and ease of repair, we will thus have not only an inexpensive, but a highly desirable road surface.

While to many, the attainment of such results with soils and soil mixtures may seem pure idealism, there is abundant evidence in Virginia, in the Carolinas, in Georgia, and in Alabama that a close approach to this ideal can be and is being made, and that very substantial betterments are secured when intelligent methods of selection and of construction are applied to the soils and soil ingredients widely available in many localities and over large areas of our South Atlantic States.

Emphasis is to be laid on the search for suitable natural soils, on a clear conception of what constitutes a serviceable road soil, on the definite examination of the material in advance of use, and on the knowledge of making effective additions to inadequate soils of those ingredients which will make them adequate and efficient.

It will be profitable to discuss the composition of soils and the basis of judgment by which a soil may be pronounced suitable or unsuitable for road building. The laboratory side will be presented first; but it must be borne in mind that laboratory methods and deductions are valuable only as they have been related to the field history of the material under weather and traffic conditions. The road laboratory of the University of Georgia has examined perhaps a thousand samples of road soils and has kept track of the service rendered by many typical samples. Out of these records spring the data and the conclusions which are guiding us in our advice to the various counties in the State.

The chief ingredients of natural soils are clay, sand and gravel, silt, mica, feldspar, lime, iron salts, and organic matter.

The value of a soil for road building is a function of the amounts, of the several ingredients, of the sizes of the particles, and of the qualities which they possess. The presence of mica in any considerable amount is always undesirable. A large per cent of lime is probably a source of weakness, on account of the softness and easy grinding of the material. The laboratory experience on this point is not large, as most of the soils examined by us have very little lime. Small amounts of lime are probably useful as a binder. Iron salts, when present, are distinctly valuable as a cementing agent, but the majority of soils carry only small quantities. Organic matter in small quantity and in a finely divided state aids also in binding the soil, but it rapidly decays and its effect is lost. In large amounts, organic matter renders the soil too soft for road purposes. Much feldspar is objectionable on account of its friability and its rapid grinding down and weathering into slippery clay. It thus appears that in general the chief dependance for service must rest upon the clay, the silt, and the sand and gravel content. The laboratory seeks to separate these ingredients and examine their char-

acter. The separation is a physical one based on the diameters of the particles.

By passing 500 grams of the dried soil sample through a No. 10 sieve, we determine the coarse residue left in the sieve, and classify it as *gravel*. The portion passing through the sieve constitutes the main sample for further percentage analysis. Various soils are thus brought to a definite standard of maximum size for comparative study. Fifty grams is taken and vigorously shaken with 200 cc. of water in a wide-mouthed bottle. It is allowed to settle for eleven minutes. The turbid water is siphoned off to a depth of eight centimeters. The operation is repeated until a clear effluent is obtained. The addition of 5 cc. of dilute ammonia hastens the washing. The exact figures given are derived from microscopic tests of the suspended sediment whose maximum diameter under these conditions will not exceed .01 millimeter. Particles of that diameter and smaller we believe to be chiefly clay. There may be also small quantities of lime and organic matter, but we are justified, after evaporating the washings to dryness, in classifying the material as clay. A further separation of the clay content may be made by digesting with water, settling for twenty-four hours and siphoning off the extremely fine sediment. Repeating this many times and evaporating the wash water we secure what may be called the "colloidal clay." The point of this tedious process is to establish the probable fact that the adhesive value of different clays largely resides in this colloidal portion, and that highly colloidal clays are needed in less amounts than less colloidal clays when we are making or selecting road soils. Moreover, the tests indicate that the shrinkage and expansion of clays is largely a function of the very fine or colloidal part; and as this expansion of the clay under rain and frost has an important bearing on the integrity of the roadbed, it is worth while to know about this colloidal clay in forming a judgment of a given soil sample. Fortunately, we do not have to make the actual separation for an ordinary sample, as we may be guided by simpler tests of stickiness and plasticity.

Turning now to the solid residue from which the clay has been washed out, it is filtered and dried, and passed through a nest of standard sieves. Nos. 20, 60, 100, and 200 are the four sizes which we have found desirable. The residues caught on the four sieves together make up what we call the *total sand*. To the very fine particles which pass through the No. 200 sieve we give the name silt. The silt is itself largely sand, but of very low diameters, .07 to .01 mm.

Examination and study of these residues and their behavior in the presence of water lead to the following conclusion: The silt aids in making a dense mass by filling voids in the coarse sand. It has no adhesive quality. When moist it has some supporting power, but when saturated it assumes the character of quicksand. No. 200 residue likewise aids in forming a dense graded mixture. It has good supporting power when moist, but loses most of it when fully saturated. No. 100 residue shows real interlocking strength when moist, and even when saturated. No. 60 and No. 20 residues show marked interlocking strength, increased, if anything, by the presence of water and not weakened appreciably by saturation.

We may now formulate a conception of the joint action of these ingredients in forming a satisfactory road soil.

First. Broadly speaking, the sand and silt and clay should form a closely graded mixture capable of packing into a dense mass with a low per cent of voids. Some of our best roads show voids of only 20 per cent, as con-

trasted with normal sand voids of 35 per cent to 50 per cent; and an actual weight of 130 pounds per cubic foot, as contrasted with ordinary earth at 110 pounds, and with concrete at 150 pounds per cubic foot. The density is at once an evidence of strength to resist traffic wear, and of ability to resist water penetration.

Second. The clay present performs the function of a weak cement which in dry weather binds together the sand particles and maintains a smooth surface. Unfortunately, in wet weather, the clay tends both to soften and to expand, and if too much is present, the traffic will churn its way down from layer to layer, and the road becomes muddy and unserviceable. Thus in wet weather, the strength of the road soil is directly dependent on the interlocking strength of the sand content, and upon the absence of excess clay which by its expansion would lift the sand grains apart, and lubricate their movement. It becomes clear that coarse sands will give better results than fine sands; in wet weather, by virtue of their greater interlocking strength; in dry weather, by virtue of their hardness and resistance to traffic wear.

Third. If a properly balanced soil bed has fortunately been secured, we may explain its resistance to weather and to traffic as follows: It derives hardness and body from the large amount of sand present, chiefly the coarse sizes, both in wet and dry weather. In dry weather, it is held to smooth surface by the right amount of clay cement, aided by iron salts and, perhaps, by small amounts of lime. In wet weather, its density and low porosity tend to exclude rapid penetration by water. The surface layer does soften and some moisture soaks downward, but the clay binder it encounters will expand and tend to seal up the capillary tubes and pores leading down into the layers below, which thus remain fairly dry and amply strong to support the traffic. If, however, the clay is in excess, or too highly colloidal, the expansion, which takes place, breaks the interlocking sand grains apart, and the weight and impact of the traffic seriously disturbs the surface and works it into mud. If, on the other hand, too little clay is present, or a clay with very slight adhesive value, the road will suffer in dry weather from dust and loose sand created by the traffic wear.

It thus appears that there exists in the use of soils and soil mixtures a limiting zone outside of which, in either direction, proper service is not secured; and within which, according to exactness or non-exactness of the composition, varying degrees of service will result. The field histories are very instructive on this point. There are soil roads of great durability, of excellent surface, of a hardness in all weathers that will carry the heaviest rural traffic. And there are others, grading down to a service just short of deep mud in wet weather or deep sand in dry weather, workable by light road drags, and calling for frequent resurfacing after rains.

The studies already made do not enable us to define with absolute exactness the limits of this effective zone, but the indications are well nigh conclusive that the range of adequate soils lies between 60 per cent and 80 per cent of total sand, and between 12 per cent. and 25 per cent of clay. Within those limits, the quality of the clay and the relative per cents of the several sand sizes and the absence of large amounts of silt are important factors in judging of the service which will be given. Much confidence may be felt in a soil or artificial mixture which carries from 30 to 40 per cent of sand above No. 60. When most of the sand lies below No. 60, a hard surface cannot be expected, although good service may be obtained if repairs are promptly made.

When the amount of total sand is low, the clay and silt percentages are,

of course, larger and conversely. The coarser grades of sand and also the gravel present directly influence the hardness and wearing value of the mixture. The finer sands, and relatively large amounts of silt and clay, lead to softer surfaces. Within the suggested limits of composition, the resulting roads may be classed as hard, medium, and soft; but even those classed as soft are free from deep mud in wet weather, or deep loose sand in dry weather, and represent a degree of service and betterment which justifies the \$300 to \$600 per mile cost. A material in which the total amount of clay and silt exceeds 45 per cent. is to be looked on as inadequate. One with less than 10 per cent clay, except in the case of true gravels, will be deficient in binding value. It is to be noted that the highly colloidal or sticky clays should not exceed 15 per cent, while the less colloidal clays may sometimes run as high as 28 per cent.

The subjoined table of analyses of roads in various parts of Georgia, all of which have given good service, and many of them exceptionally durable, will throw some light on the manner of reporting road soil analyses. The best samples are marked with stars, the medium ones with daggers, and the softer sand-clay roads with the letter s.

The following table of mechanical analyses has been made by Adjunct Professor S. B. Slack by the new and more complete methods adopted by the laboratory since 1913:

TYPICAL GEORGIA ROAD SOILS.

Analysis After Separation from Gravel.

COUNTY	Diameters in Millimeters							
	Gravel	Sand					Silt	Clay
	Above 1.85	1.85-.86	.86-.24	.24-.14	.14-.07	Total	.07-.01	.01-.00
North Georgia								
476 Cobb.....*	4.0	8.0	33.0	17.6	13.6	71.2	15.0	14.0
466 McDuffie.....*	13.0	19.6	44.6	8.0	6.0	78.2	4.5	15.0
150 Clarke.....*	3.0	8.5	36.0	12.5	11.3	68.3	16.2	15.0
10 Clarke.....†	-----	7.8	34.3	9.2	9.0	60.3	12.8	25.0
Middle Georgia								
108 Dougherty.....†	0.8	0.8	30.1	15.4	20.0	66.3	14.1	18.0
124 Sumter.....†	-----	8.0	22.0	14.7	15.3	56.6	14.6	27.5
424 Muscogee.....s	-----	2.8	8.3	18.4	25.0	54.5	12.4	31.0
120 Bulloch.....s	10.4	4.6	22.0	14.7	15.3	56.6	14.6	27.5
106 Bulloch.....†	10.0	4.0	30.0	18.5	12.1	64.6	13.6	20.0
South Georgia								
434 Emanuel.....s	-----	2.4	9.2	19.7	27.0	58.3	12.8	25.0
103 Brooks.....†	-----	2.7	20.7	21.2	26.4	71.0	14.8	14.2
113 Mitchell.....*	-----	2.0	32.0	20.8	17.4	72.2	13.4	14.0
Special								
470 Augusta Gravel...g	15.2	28.0	54.4	6.0	2.2	90.6	3.4	6.7
116 Pipe Clay.....w	-----	14.3	16.9	4.8	4.7	40.7	8.8	50.0
Sieve numbers.....	10	20	60	100	200	-----	-----	-----

NOTE—* Hard and very durable. Few repairs.

† Medium and good service. Moderate repairs.

s Soft. Must be frequently reshaped. Repairs \$25 to \$50 per mile annually.

g True gravel—excellent quality.

w Worthless.

The following road histories attach to the respective samples. The laboratory proposes to visit again these roads and others built later under its advice to supplement and extend the data regarding field efficiency and repair costs, preparatory to a complete bulletin of the laboratory's investigations:

Sample No. 476. Atlanta-Marietta Road, Cobb County. Taken in 1914 from roadbed. Topsoil. Very hard and smooth. Not cutting. Heavy traffic. Age one year.

Sample No. 466. Thompson-Augusta Road, McDuffie County: Taken from roadbed, 1913. Topsoil. Very hard and smooth. No mud. Heavy auto traffic. Age one year (?).

Sample No. 150. Athens-Danielsville Road, Clarke County. Taken from roadbed in 1912. Topsoil. Very hard and smooth.

Now as to the gravel. Comparatively few natural soils contain large amounts of gravel, and yet we have encountered in our Georgia experience a number of soils which may be fairly called semi-gravel soils. They have made most excellent roads where the coarse particles were of hard siliceous material. In these cases, we may think of the soil below No. 10 sieve as an earth mortar, and of the gravel itself as corresponding to the broken stone in concrete. How much of the gravel will this mortar carry? The answer is, any amount; for the gravel rapidly adds supporting power, hardness, and interlocking strength to the whole mass, and if it becomes large in amount, it passes into the true gravel road with the soil filling the voids. But gravel exceeding two or three inches in diameter is objectionable, and unless the gravel is graded in size, it may be a source of trouble. I have just seen in Orange County (Virginia) a soil which carried about twenty per cent. of a rounded gravel of virtually uniform size on top of a soft soil having only a small amount of sand. The lack of grading in this soil and gravel mixture deprives it of interlocking strength, and its use was a virtual failure.

The hardness and quality of the gravel is to be carefully watched. Frequently it is composed of feldspar, or of micaceous masses, or of indurated clay. These are all too soft, and break down under traffic into undesirable elements. Nothing is worse than mica in destroying the efficiency of an otherwise good road soil. Some soils have been examined containing two to three per cent mica that have given excellent service, but any larger per cent is highly undesirable. Feldspathic gravel is likewise undesirable as it rapidly grinds down under traffic into a slippery clay-like material. Indurated clay nodules are, of course, worthless.

During field inspection, the gravel residues where water has been running give a useful indication of the quality of the soil itself, by showing the kind of rock masses from which it was derived.

I have dwelt upon the laboratory side of road soils, because it is time to recognize some standard of examination from which to accept or reject a given soil material for road surfacing. The proposition has seemed so simple, to harden a clay road with sand, and to bind a sandy road with clay, that many very crude mixtures have been made and many poor natural soils have been selected to the great disappointment of both the taxpayer and the road builder. Bad errors of this sort can be avoided in advance of construction by submitting the proposed soils to examination by a competent road laboratory. The need of such laboratories in our Southern States for the study of this class or road materials is a pressing one and their work can do much to perfect the methods and the results. But such laboratories must work in close touch

with the men who are actually building the roads, and must derive their laboratory conclusions from a close study of the road history of the samples examined.

Much of the success of building soil roads depends upon the man in charge of field construction. His thoughts should dwell upon and his methods reflect the following important aims:

First. To secure a natural soil, or to make an artificial mixture of the *right* composition. The laboratory must aid him in this.

Second. To bring about a thoroughly uniform mixture before consolidation is attempted.

Third. To deposit in one thick layer an ample quantity of the material.

Fourth. To see that it is packed from the bottom upwards.

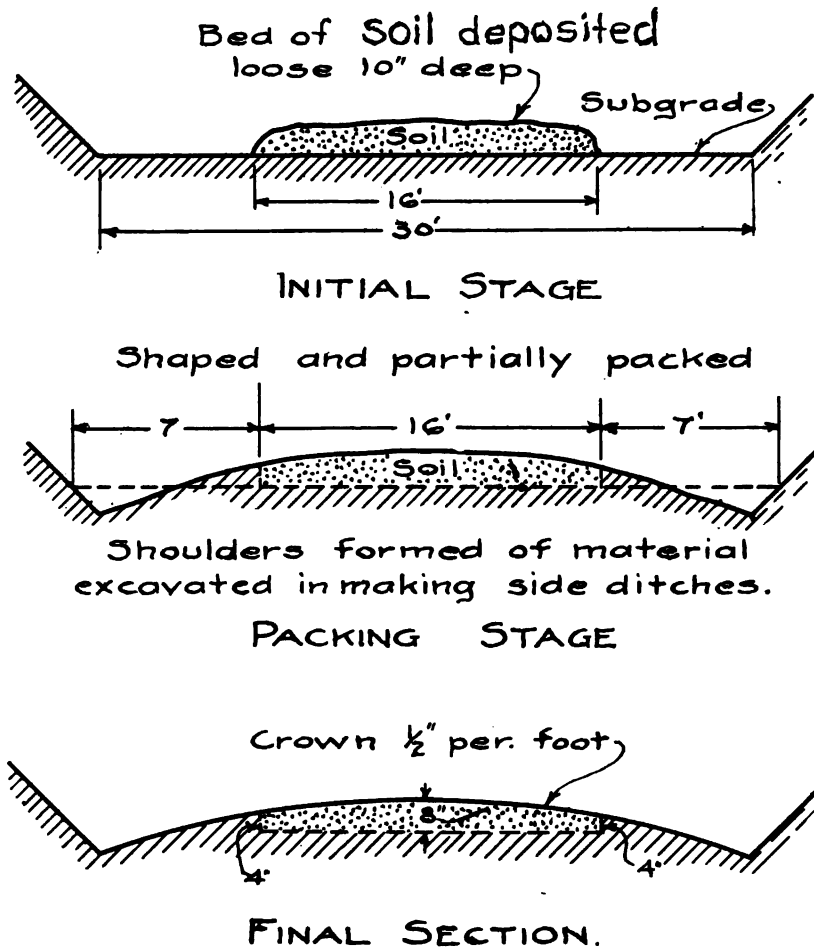
Fifth. To watch it carefully during packing, and constantly to use the road machine in maintaining the proper shape and crown.

Nothing can take the place of the first item. The search must be made for a natural top soil of adequate composition, or the local soil must be examined and its deficiencies made good with sand or clay as the case may require. In many parts of North Georgia, excellent topsoils are found in detached areas on hilltops and ridges, not far from the road. Often a topsoil which is too sandy is corrected by plowing into the clay subsoil, and mixing by harrows or in loading. Sometimes, when the nearby soil is slightly deficient in sand, sand from a branch or creek is hauled and mixed in. In middle Georgia a substratum of natural sand-clay found within a short depth from the surface is widely distributed and is of good composition. It is excavated and used. The sand in this material, while sufficient in quantity, is rather fine in size. The roads are good, but of medium hardness and need frequent dragging. In South Georgia, overlaid with sand, the search is for clay outcrops, and for substrata carrying clay. Artificial mixtures of sand and clay are made; thorough mixing by plows and disc harrows follows; and then consolidation by the action of the traffic. In all parts of the State local methods vary with the materials to be found. I have no doubt that North Carolina has been following similar methods of search and use. But all of us have given too little attention to assuring ourselves in advance that our mixtures were of adequate composition. To illustrate, the second item, Muscogee County, in charge of Mr. J. R. Lane, Columbus, Georgia, is a striking example of the value which attaches to thorough mixing of these soil ingredients before consolidation. It would pay any road engineer in a sandy section to visit and inspect the work and methods in Muscogee County.

As to the third item, anyone who once has tried to deposit this type of material and allow it to pack in successive thin layers will know already the importance of not doing it again. A solid deep bed deposited in one layer not less than ten inches thick, and consolidated as one mass, is a most vital requirement of this work. Our clay binder is weak at best; it softens on the surface in rains, and we should not risk the breaking through of the traffic into the subsoil below. Greater thickness than ten inches should be used when the foundation is of weak micaceous or silty soil, and where it is subject to softening or saturation from below.

The fourth requirement of packing the bed from the bottom upwards is commonly attained by reliance on the hoofs and wheels of the construction teams and the traffic. It is surprising what density and even uniformity of consolidation follows this simple process. The ordinary roller is worthless.

It forms a crust which breaks through in wet weather. But if some type of roller with multiple narrow tire rims could be devised, a soil road consolidated in this way would repay the extra cost. The sheep foot, or petrolithic, roller is on the market and has been used successfully in California. Its price is



STAGES OF CONSTRUCTION "TOP SOIL" ROADS

FIG 7

high and it requires much power to operate it. I have not heard of its use in any of our Southern States. During consolidation it is a blessing in disguise to have a spell of bad weather on a freshly laid soil road. The tem-

porary puddling and deep mud mean denser packing as the road dries off and a more durable road.

The process of consolidation by the traffic occupies several weeks or months according to the weather, and during this time it is extremely desirable that the surface be promptly reshaped after rains in order to avoid lumps and to ultimately attain a smooth, evenly crowned surface.

What may be called the approximate standard section in our Georgia roads is shown in the accompanying figures, and also the steps through which the road goes in construction and consolidation. Fig. 7.

The past winter, with its unusually protracted rains, has seriously tested the merits of every improved soil road in the South. Many reports have come in of failures and partial failures. But along with these other reports have come of surprising service from roads built with due regard to the principles I have just presented. There is nothing to warrant abandonment of the soil road; there is much to stimulate us in perfecting its merits by avoiding our obvious mistakes.

The first of these mistakes has been in lack of care in the selection of the soils used. It is easy to be satisfied with a soil very close by the road, or one which the landowner will donate free of cost, without taking steps to assure ourselves that it is a really suitable soil. This is none the less a mistake, which a long wet winter invariably will reveal. A road soil which is not really a road soil of the proper composition will not make a durable road.

The second mistake is that in our hurry to build many miles which the public so greatly need, we have not used an adequate thickness of the material. We have laid thin beds four and five inches thick and have demanded unreasonable service from them. It is like making a child carry two bushels of corn to mill on his shoulder. I have been surprised at the manful effort which many of these thin road have made, lasting through several ordinary winters, and yielding only under the severest stress of weather and traffic. Nor is everything lost when such a road breaks through and cuts to pieces. A new layer of good soil of the same thickness as the original one will be stronger by virtue of the improved foundation. If the softened road be lightly plowed in wet weather and a six or eight inch layer of good soil be spread on it, the new consolidated bed will most probably be entirely strong and adequate, unless the subsoil was very micaceous and silty.

The third mistake has been that in our repairs of these roads we have allowed ditch scrapings, or poor soils from the sides, to be spread back over the good material to its rapid injury and ultimate destruction. Far better to leave the road surface untouched for a long period of time than to destroy it by semi-annual layers of soft material spread over it in the name of repairs. The contents of the side ditches should be shoveled or hauled entirely away from the road.

A fourth and very serious mistake, one that contributes to careless repairs, is the impression that a road once built is going to last forever, and therefore no thought need be taken to have on hand the proper soil materials for repairs and needed reconstruction. The readiest excuse in the mouth of the foreman is that he had nothing except what he finds in the ditches or on the banks with which to make repairs. If the soil road is to be looked on as a permanent thing in our road policies, and not simply a temporary makeshift, road officials must recognize the absolute necessity of purchasing, or securing by gift, adequate supplies of these materials in advance, at reasonable inter-

vals along each improved road. The well-built road of this type may be counted on for a life of ten to fifteen years or possibly longer; but this outcome requires systematic maintenance with materials equally as good as those which compose the original bed.

That the repairs of such roads are easily made and small in annual cost, is one of their most fortunate advantages, but a failure to make the repairs systematically and with proper material means rapid deterioration, reduced life and distinct loss of both money and traffic service.

DISCUSSION.

MR. MARTIN.—I would like to ask which part do you put down first, clay or sand?

MR. STRAHAN.—Usually in sandy sections it happens that the original bed is sand; so the first thing to put in artificially will be clay; but in some cases you do grade down through the hills of middle and southern Georgia and you are on a clay mass. Therefore, it depends upon the local quality of the material, whether it is sand or clay. You either just simply bring in a natural mixture or make alternate layers of sand and clay. In a section like this where you have such a superabundance of clay, I think I would put my layers in such a way that the sand layer would come last, on top; but this would depend upon how many layers I had to make. In using the layer system, you must be sure to mix thoroughly and not leave the sand and clay in stratification. It would go to pieces, one layer after another. That is why I emphasize putting this bed in as a solid ten-inch bed and letting it pack together from the bottom up.

MR. FALLIS.—Please tell us why you use a thirty-foot instead of a narrow road. A great many of our counties want to use a narrow road. Please explain.

MR. STRAHAN.—That is our standard first-class road. There are narrower roads in Georgia than that. I think there are a great many merits in view of our traffic needs and water conditions that seem to call for the thirty-foot road. First of all, it is hard to understand how you can get along without the two track space for your automobile traffic. In Michigan they say they build a gravel road nine feet wide with deep ditches on each side. That is a right good tribute to their topsoil, because if it was anything like our clay, we would soon get into a great deal of trouble. But I cannot quite see the nine-foot road unless it is supplemented with something good on each side. What is the minimum you must have for those two tracks? That is clear if you are going fast * * * I prefer and want a flat, shallow side ditch in preference to a deep one. I think deep ditches are dangerous. The Michigan plan is a nine-foot road with these deep ditches on each side, and if a scary team and an automobile meet, I do not know what happens. Providence must take care of them like it does in the mountainous counties. I prefer the shallow ditch. A shallow ditch will resist erosion and breaking down so much better than a deep ditch. In most of Georgia we seldom have anything less than twenty-four feet wide—some may be twenty—but our standard road is thirty feet.

In cleaning out the side ditches the material was naturally scraped towards the surface. In November or October during good, dry weather, that work was done and this mass was left here. In December in Georgia there came this heavy rain. It soaked as much as it could but particularly right in this

deposit—four or five inches of this bad material into this material below. Traffic came along on it and would cut in deeper here than over here in the topsoil. Finally the stress was so great as to actually break through the mass. It was simply a warning against making deposits of old, washed material on a bed of the good sand-clay mixture. You can take a cubic yard of poor soil and injure 25 to 30 square yards of surface of good road.

MR. STACY.—I want to emphasize one thing from another point of view, and that is to guard against the matter of haste in the making of these roads. Not only does it make a poor road, but it makes a much more expensive road in my judgment. Somebody in the last analysis must pay even for the cheap sand-clay road, either through a bond issue or direct tax on the people. I have had this experience that bears right on this line and corroborates what Professor Strahan has very forcefully presented to us, and what we learn by experience we are pretty apt to remember.

Where the road has been hastily built the bills for surfacing material have been exceedingly high. Where there has been some question about meeting a certain road or where there has been a choice between two different roads, if the engineer working with a commission will go and select his material, will keep in mind where he can get this material or where it can be obtained, if he can go slowly, then he will save hundreds and thousand of dollars to the taxpayers in the ultimate cost of the road in surfacing materials. In addition to that he will get a far better road because of that.

MR. PRATT.—One point I want to bring out—the thing of a thorough mixture of the materials—if you are going to add them separately to the road. If you are going to start with a clay base and add sand to that, or if you have a suitable sand and add clay to that; in both it is absolutely necessary to have thorough mixing. I have a good illustration of this in Henderson County. About eight or nine months ago they wanted to make some sand-clay roads in Henderson County. They had a pretty good quality of clay subsoil and all that they expected to do was to add the right proportion of sand to that clay. They wanted to know how to do it. We sent up a general specification for making a sand-clay road. The supervisor wrote back that they could not do it that way. They wanted to know what would be the results to put the sand on the road and leave it to the traffic to do the mixing. I wrote him that he could in the end get a pretty good road that way, but it might take from eight to eighteen months before you get a thorough mixing. They had no chance to get that sand-clay mixed this past winter and these roads have been almost impassable. They have a thorough mixture now, I think, of the sand-clay. I do believe, however, that when that road gets ironed out and dragged into shape it will be a hard road, but not as good as it would if they had made that thorough mixing at the beginning and then dragged it out and brought it into shape. In the end it has cost the people just as much as if they had gone ahead and made the road right in the beginning. The other point to emphasize—where you have to put the material on in layers, a layer of clay and a layer of sand—is the need of more thorough mixing before these mixtures get packed, because if you do not, the water will get down and soften it and you are going to get a mean, muddy, soft road during the rain.

Question.—In speaking of sand on top of clay, about what per cent of sand washed away before it got mixed by traffic?

MR. PRATT.—There was not a very large per cent, but a certain amount of

sand went down into the ditches. One other thing to mention in regard to ditches. I may be too much of a crank on the question of material you find in ditches. I have tried to get the men to take a definite stand that no material that is down in the ditches—not on the shoulder, but down in the ditches—shall ever be brought onto the surface of a road because there is always going to be a certain amount of mulch or vegetable matter in that material. No matter how nice it looks, that material should never be brought back upon any part or portion of the road and particularly that portion that represents the surfaced part of the road. In order that there may never be any chance of bringing that on the surface, I have tried to make it a cast-iron rule that the stuff in the ditch shall be thrown on the opposite side from the road. If that material is piled on the edge of the ditch, rains come and it is washed back into the ditch. Throw it on the opposite side from the road. Keep it away from the road.

MR. SPOON.—I have had more field than laboratory experience, but it furnishes us the basis for our knowledge, and it likewise gives us some vital suggestions in regard to actual construction. There are a good many young men I see before me today who expect to make road work their calling. To them I want to say this, that in the successful building of a sand-clay or topsoil road, eternal vigilance is necessary. You have got to be on the job. You have got to watch constantly, because you cannot take every shovelful to the laboratory and analyze it; you have got to use common, plain, practical judgment and close care in making selections of materials, and, above all things, you have got to be careful to select the foreman who does this work. He must be a man faithful, good and true to your instructions.

I want to emphasize this: Remember never to put new material on the road in the fall of the year. Clean out the ditches and throw the material out on the banks in the fall of the year, but leave your roadbed smooth and hard and do not add anything to it. In the spring add necessary materials which will add strength and become part of it. By going over and studying the road conditions throughout a county, you will learn by observation the things necessary to be known, and some of these little things are the crucial things. The things you will observe by going through any country or community where roads exist naturally will point out to you suggestions and ideas valuable in road building.

MR. PEYTON.—One question in reference to the disposing of the material in ditches. I have a good deal of heavy side-hill work and have trouble in the disposal of the material. I have several cuts which are really too deep to dispose of the erosion material in the ditches; some of them 500 or 600 feet long in the cuts. I would like to have some one give me an economical solution of how to dispose of that material; whether to take it up with scrapes to the grade point or to any point in the cut, say the shoulder where it could be disposed of in the construction of the road, or had those ditches better be left deep enough to take care of the road?

Answer.—The only way I see to get around that is to put the hip or drag scrape into those ditches and carry that material to the grade point and dump it off on the fill and then round up your road with road machine or drag.

MR. PRATT.—Have you got the ditches out of the cut so you can carry the water from the mountain side so none can come down from this slope over the road? Of course you may find it necessary to increase the slope. You will find some will stand up very steep and other places require much more

slope in order to get the material to stand up. I believe it is almost impossible for a man to be able to account for a great many of the slides we have in the actual construction. You will, in your mountain work for perhaps two years after the road is constructed, find that you will have to contend with these slides due undoubtedly to geological conditions affecting the decomposed rocks. Finally you get a stability of the side cuts and you will not have much trouble with it.

Sand-Clay and Topsoil Roads in Craven and Wayne Counties

By R. E. SNOWDEN, Road Engineer.

There is such a wide difference in local conditions, soils and the requirements, between these two counties, separated as they are by only one county of about fifteen miles in width and lying along and drained by the same river, the Neuse, that to properly treat the subject of sand-clay and topsoil roads in the two counties it will be necessary to divide and describe the two under two separate and distinct heads.

First, we will take Craven County. This lies within twenty-five miles of the ocean and is divided into three sections by the Neuse and Trent rivers. The land lies so flat, after it rises above the streams and marshes, that while there are very few engineering difficulties, thorough drainage is very difficult and expensive. There is no soil found in the county that will make a surfacing material that will hold up under heavy traffic.

The rivers are bordered by low swamps, that are subject to overflow for a distance of from one-quarter of a mile to two miles. All the streams in the county are tributary to the Neuse River, which is subject to a storm tide of ten feet above the average stage. Back of these swamps are belts of beach or river sand, that drifts to a small extent under heavy winds. This is usually underlain with marl or coquina rock, often so deep as to make it impractical to strip off the overburden. Behind these belts of sand lie the stiff or clayey soils, the savannahs and pocosons. The savannahs occupy about one-half the land area of the county. They consist of very level land lying about ten to fifty feet above tide, composed of gray, sandy soil, underlain with silty clay, covered with longleaf pine, native grass and sometimes very scant growth of underbrush. Some of the savannahs have been drained and are in cultivation. The pocosons are shallow, elevated basins, almost perfectly level, covered with a dense growth of bushes, briars, reeds and vines, with a very scant growth of pines of very inferior quality. The soil is black, peaty muck, varying in depth from a few inches to seventeen feet, which burns readily when dry. This is underlain with clay and sand or pure sand, generally, but is sometimes underlain with a kind of black clay known locally as "bay soil." Around the pocosons, on the side towards which the water would naturally flow, there is usually a slight ridge that helps to retain the water. The pocosons occupy about one quarter of the area of the land in the county.

New Bern, the trading point of Craven and several of the adjoining counties, is located at the junction of the Neuse and Trent rivers. The soil in the town and that for four miles out of town is a fine river sand and sandy loam and silt (Norfolk fine sand and Norfolk sandy loam). Much of the commerce moves both to and from New Bern by water, but there is enough by road to make the traffic very heavy on the four roads leading out of town. There have been built within four miles of New Bern seven pieces of sand-clay road, all of which have been failures. The first two were built by high-

way engineers, as experimental roads, the money being supplied by local subscription, and the engineers by the Office of Public Roads. The next three were built by inexperienced foremen. The last two were built by the writer to convince the local authorities that successful sand-clay roads could not be built out of the material available in the county. All were of the clay on sand base type and failed rapidly under heavy traffic, except one the writer built on the sand ridges on the east side of the Trent river, and in that case the sand fill under the clay blew away before a Bermuda sod could get started and before traffic could break down the road. The instances of failure that came under the writer's observation, and he feels sure the others were from the same cause, were due to the sand being too fine and water worn and the clay containing too high a per cent of silt. The best material that could be obtained was used in the first and last two instances; had the average material of the county been used in these sand-clay roads, the failure would have been much more rapid and complete.

The rapidity of the failure of some of the early experiments may have been due in part to the lack of proper maintenance, but this was not the cause of the latter failures. During the past year that part of the Central highway that lies in Craven County's part of the Newport pocoson has been drained and shaped out of the black peaty muck and surfaced to a width of twenty feet, with twelve inches of topsoil, known locally as savannah soil. This material was taken from the savannah just west of the pocoson, hauled in and spread to proper depth, and smoothed with a light road machine, without mixing, and held to proper shape and smoothness with a road drag. This soil is gray in color, contains much sand and some silt with considerable clay. This work was suspended last November as it was all complete except fire-proofing the roadbed against the fires during the summer droughts. During the heavy rains and long cloudy weather in December and January this road has stood up exceedingly well, there being no time in these two months that an automobile could not be driven from the beginning of the pocoson to the Carteret County line at a speed of twenty miles per hour, with safety and comfort. All that is needed to make this road good three hundred and sixty-five days in the year is a little maintenance now and then, as needed.

It has been the writer's experience and observation that wherever the roads have been built of, or surfaced with this savannah soil they have withstood fairly heavy traffic, much better than the sand-clay that could be built out of such material as we have at hand in Craven County, and for that reason he has recommended that all roads carrying heavy traffic be surfaced with coquina rock, known locally as shell-rock.

Wayne County is about ninety miles from the ocean, is gently rolling and lies just above the Coastal Plain. There is very little swamp land in the county and all the other lands are gently rolling and easily drained. The county is divided by the Neuse and Little rivers. All watersheds in the county are tributary to the Neuse River. Most of the lands are in cultivation. The soil is generally gravel, sand, clay and combinations of sand and gravel and clay. Most of the sandy soils are underlain with clay. There is a plentiful supply of well distributed material throughout the entire county, suitable for excellent gravel, sand-clay and topsoil surfaced roads, especially sand-clay and small gravel roads. There are found frequent deposits of coarse, sharp sand and rich clay occurring together in the right proportions, free from detrimental soils of any nature. Along the beds of the two rivers are found

frequent beds of river gravel, grading in size up to one inch, usually mixed with small gravel and clean, sharp sand. Along the sides and valleys of the rivers and in the old beds of the streams are found frequent beds of the same material. Deposits of excellent sand are found at the heads of the ravines and on the slopes of the hills just above the streams. Good rich clay very low in silt is found below the tops of the hills on the slopes, usually on the eastern slope, in the stream banks and in the old beds of the streams. The swamps are generally long and narrow; the streams not subject to sudden overflow.

Wayne County has for a number of years tried to build sand-clay roads, but they have been more or less a failure, due to the lack of intelligent direction of the forces. The soil had been poorly selected, and proper care was not exercised in the mixing, in fact very little or no mixing was done; especially was this true of wet mixing. There was some sand-clay road that in places was all right, but there was not that uniformity of durability in the roads that a well proportioned and well mixed surfacing material usually possesses.

Goldsboro Township issued bonds in 1913 for the construction of good roads in that township. In the spring of 1914 the writer was engaged by the township road trustees to do the engineering for their roads, and under their supervision was built the Stantonsburg road and the Pikeville road. The roads were relocated by him on a maximum grade of three per cent and a maximum curve of ten degrees, and designed and built with a width of thirty feet with a surfaced width of twenty feet, having a crown slope of 1:20. Small waterways of double strength vitrified shale pipe with concrete headwalls. Intermediate sizes of reinforced concrete culverts and all large sizes of the "I" beam type of reinforced concrete bridge, having all beams thoroughly encased in concrete, the floor system of concrete reinforced with expanded metal between beams, carrying twelve inches of surfacing material across the bridge, in that way leaving no break in the roadway or surfacing material; all designed and built with a safety factor of five to carry a load of twenty tons.

The road was graded true to grade and the deep sandy places left flat; the clayey places shaped true to crown. On the sandy foundation there was placed three inches of good rich clay, spread over a width of twenty feet. This was then plowed, beginning at the sides and turning out until the entire road was plowed. Next there was placed on the road a double roll disk harrow of ten disks to the roll and the road was harrowed until the material was thoroughly pulverized, when it was again harrowed, beginning at the middle of the road and turning the material in until the entire road was plowed, care being taken in each instance not to take too much width at each furrow. The road was then harrowed with the same disk harrow as before until the material was thoroughly pulverized. The next step was to shape up the road with a road machine and allow it to rest until the first good soaking rain, when it was thoroughly puddled with a tooth harrow until it was a complete slop, then allowed to dry out; and while drying the road drag was used to keep it in shape until it was thoroughly dry, and true to shape. Over this there was then hauled and spread three inches of the best sharp, coarse, gravelly sand, and allowed to lie until the first rain, when this was cut in with a disk harrow and thoroughly puddled as before. The clayed places were plowed to a depth of three inches, beginning on the edge and turning the furrow out, thoroughly disked, and over a width of twenty feet was placed

four to six inches of good sand, sharp and coarse, thoroughly disked in and again plowed, beginning at the middle and turning the furrow in toward the middle of the road, again thoroughly disked until all the material was completely pulverized, shaped true to section and allowed to rest until the first soaking rain, when it was thoroughly puddled and then handled as clay on sand, as described above.

Goldsboro is the center of trade for Wayne County and much of the surrounding territory. As these roads begin at the edge of Goldsboro and lead to the township line, supplying a well developed agricultural section beyond, the traffic, both on rubber and steel tires is very heavy. During the recent heavy rains in December and January these roads have held up almost perfectly in spite of the heavy traffic coming upon them, much being on heavily loaded wagons with narrow tires.

Observation and experience lead to the inevitable conclusion that with the material at hand, such as Wayne County is fortunate to possess, all that is needed is care and skill in selection, proportion and mixing to get sand-clay roads that will be second to no other type of road.

Sand-Clay and Topsoil Roads in Orange County

By R. T. BROWN, Road Engineer.

If, during the past two and one-half months, the general public of Orange County had been asked for its judgment on the serviceability of sand-clay and topsoil construction for this section of the country the answer would have been very discouraging. The large amount of comparatively new work, the present limited system of maintenance, and the unusually severe weather conditions during this period have combined to make it appear that we needed a "365 Day Road Club." But with the return of clear weather and a few windy days the roads, with a few exceptions, are showing up better than many people thought. However, we understand by an improved road one which is better than the old road, not only in width and grades, but also in the condition of its surface in all kinds of weather. Hence the question regarding the roads of this county is: "To what extent have they exhibited the qualities of improved roads?"

As regards the kind of surfacing material used, there are four general classes of surfaces on the recently built roads in the county.

The first, used on only one short stretch of road, is artificial sand-clay. It was constructed by hauling river sand and fine gravel and spreading on a clay surface, then mixing by means of a disk harrow and shaping with a wooden drag.

The second class of material is a natural sand-clay mixture, obtained in a few cuts and pits. It is the remains of a decayed granite and has not had the weathering and the intermingling of vegetable matter that are brought by cultivation.

The third class, and by far the most extensively used here, is the topsoil surface. This is of practically all grades of topsoil in which there is any appreciable amount of sand and gravel.

The fourth class consists of a natural bank gravel, containing about the proper amounts of sand and clay or loam to bind it well. It is this material that is used on the Durham road from a point just east of the flat bridge for some distance toward the county line.

I will discuss briefly the qualities of each as a surfacing material, as shown by the results attained in this county.

The artificial sand-clay road was constructed in a rather random fashion, the hauling being done by local teams when they were not otherwise employed. Some of the sand and gravel was allowed to remain in piles in the center of the road for two or three weeks, until a sufficient amount was hauled to justify spreading and mixing. The sand on a part of the work was put down in two layers, each being worked in with a harrow. On this portion the road has stood up well, even though lumber and ties were hauled over it during the rainy weather. On the portion where only one layer was put down and that not thoroughly mixed, there is but little to show for it except in the track where the teams walk. But where the two layers were used and the mixing and crowning properly done the road did not rut seriously, except where shaded. In the heavily shaded spots, which happened also to be places where the drainage was poor, the wheels cut through and the whole width of the road became pretty muddy.

The Durham road from the town limits to the new bridge is the best example we have of a natural sand-clay surface. This material is from pits near the road, though it is exactly the same material as was excavated from parts of the cut along there. A part of it came from near the surface, while a part was taken from a considerable depth. The small gullies and ruts in the road surface proper are, in my judgment, due to the fact that much of this material had never been broken up so as to give the water opportunity to leach out sufficiently the more soluble portion. Therefore, when it was put on the road it first took up too much water, which made it expand, and hence more subject to the cutting action of the wheels. Then when so much material was softened it was easy for the additional rain to carry it away. If there had been only about half as much soluble material in these places the surface would have packed about as well and would not have absorbed so much water. For this reason I believe that this stretch of road will continue to improve for three or four years, during which time the less desirable material will leach out. This is, of course, conditioned on there being proper maintenance provided to prevent washing. One quality of the natural sand-clay mixture as it occurs in pits like these that gives it an advantage is the large percentage of coarse, sharp grains of the sand. In some cases it approaches a gravel mixture rather than sand-clay. I believe that, with a sufficient quantity of binder and filler, the resisting power of any sand-clay road is almost in a direct ratio to the size of the sand grains.

The topsoil surfaces consist of almost anything from light colored loam to coarse sand and gravel. In some cases the binder is clay, in others loam that contains very little clay. In some sections it is very difficult to find any suitable material for use on the kind of base that one finds in the same localities. This is especially true of the western ends of the two branches of the Central Highway through this county. There we had clay roads and but little sand or gravel near at hand. We used whatever gravelly soil we could find even though it contained considerable clay. Where the red clay was used it has given fairly good results. But in places where much light colored clay was used it gets dusty in dry weather and cuts in wet weather. In other places the soil was so sandy that it did not bind well when put on without being mixed with clay or loam. In these places it does not become muddy but the surface wears into holes, making it uncomfortable to ride over.

The best topsoil surfaces are found where the material was a very gravelly soil with a slightly sandy loam for a binder. Within reasonable limits the more gravel, the better the surface has held up. The dark soils have in almost all cases made better surfaces than the lighter colored soils, no matter on what kind of foundation they are compared.

If a topsoil is used that contains a binder in sufficient quantities it does not necessarily have to be mixed with the material of the roadbed, nor does it require to be mixed within itself if it is taken from cultivated land. Care, however, must be used in placing it on the road not to use consecutive loads from different portions of the field, as the soil with more loam and less gravel will be compacted more and leave a wavy surface. In many cases the surface would be improved if the topsoil were mixed artificially.

There occurs at a few places in the county a soil containing an almost black gravel. This gravel looks as if it would be an excellent surfacing material, but when used it quickly breaks down into the toughest clay to be found in the county. On examination it is found to consist of particles of the less soluble minerals from a granite, held together by the feldspar still in place but almost completely turned to clay. When the lumps are broken the interior is seen to be composed largely of clay, some of which is still granular. Therefore, when the outer crust is broken by traffic, the gravel immediately disintegrates to form a clay that is much less plastic than that which has been longer exposed to the air. In any section where the soil is derived from a granite or gneiss it is well to examine carefully any dark gravel before using it for road surfacing.

There has been only a small amount of bank gravel used for surfacing in this county. The Durham road from the flat bridge to the top of the first hill east of the little store was surfaced with a good grade of bank gravel. It has stood up better during the bad weather than any other piece of road in the county. The material occurs over a limited area in that section and in rather shallow deposits. The supporting material is largely quartz sand, but there is enough clay and loam in most places to bind it satisfactorily. At a depth of a foot or two the sand and gravel disappear almost entirely; the material there being practically all red clay.

The recent failures of so-called sand-clay roads have brought this and the allied topsoil surface into great disfavor. But I think it is not so much a failure of sand-clay as it is a failure to use sand-clay. If sufficiently coarse material and sufficiently little clay had been used, there would not be so many taxpayers swearing that their money had been wasted. But, as an old Scotchman said to me a few days ago, "There is always some reason given for the failure of these sand-clay roads," and what the people want is roads, not reasons. It is therefore, very important that in the future experienced and reliable men be put in charge of surfacing with these materials in order to redeem this type of construction. Otherwise many communities will be constrained to go for many years yet without road improvement because they are not able to build macadam and are not willing to invest their money in something that will not, in their judgment, prove satisfactory.

Reports from Counties

FRANKLIN AND VANCE COUNTIES.

By W. S. FALLIS, Road Engineer.

The cost of maintenance on water-bound macadam roads is excessive, as we all know; but to illustrate, I want to cite one example. Say a county

has quite a number of miles of macadam roads, totaling perhaps 250 miles. To properly maintain this it would cost them \$100 to \$150 per mile, say \$125 or \$31,250 for maintenance, and perhaps then they are limited to that amount of road work. If it take the \$31,250 a year to maintain their macadam roads in good condition, and this amount is the limit that the county can raise for roads, they are bankrupt in so far as the construction and maintenance of new roads are concerned. There is one thing we all ought to stress; that is, always build a road so it can be economically maintained, so the cost of maintenance will be as low as possible and within the means of the county. There are two or three things I want to say in that connection. We all understand that poor drainage is the greatest enemy of the road. There are several phases of drainage that affect the maintenance especially. One of the great troubles is a general lack of information as to the effect of the width of the road on its maintenance. A road that is built too narrow to afford proper ditches sufficiently far from the traveled part is a great deal harder and more expensive to maintain than one built of sufficient width to give proper drainage from the traveled part. I contend that you can build a road thirty feet wide through average level country where fills do not exceed eighteen inches and cuts do not exceed eighteen inches for as small actual cost of construction as you can build an eighteen-foot or twenty-foot road, for the reason that the handling of the outfits in making the narrow road, and keep from doing damage to property outside of the right of way is more difficult than for the wider road. In turning a road machine it is easier, and less expensive, to the work to turn on a wide road than on a narrow road. For these reasons I am satisfied that the little difference in the yardage to be handled will be overcome by the facility with which the work can be carried on.

The great advantage of keeping the water in the ditches at least seven feet from the edge of the improved surface is vital to the cost of the maintenance of the road, and to its continued good condition.

In Franklin County most of our roads this winter have been all right. We have had a few mud holes here and there, but nothing to cause any dissatisfaction with the kind of construction or cost of maintenance.

The road work in Vance County has not been maintained properly this winter, and I account for the five miles of bad road that I reported largely because the maintenance was not properly carried on in that part of the road. The road was built of a soil that had too much mica in it, and the rain falling on that, of course, softened the whole surfaced portion of the road, and it was not given any attention. I do not think this road would have been bad at all except perhaps a little pasty if the roads had been dragged immediately after every rain. The rain falling on the small ruts and depressions made by the wagon tracks and horses' feet were filled with water, and as this water was allowed to remain it softened the sub-grade and ruined the surfacing. If they had gone over this road with a drag and cleared the water off immediately after each rain, we would have had the road dry in a little while and the water would never have had an opportunity to injure the sub-grade and thereby ruin the road. As to the maintenance problem, in general, there is a good deal of talk of various methods involving the use of the motor truck and tractor as maintenance tools. These machines as at present developed I do not believe are efficient tools for the purpose. I believe, however, that we will get in a short time a good maintenance tool in some form in the light tractor. I do not believe there is any tractor or motor truck now made that is an

efficient maintenance machine. They are too heavy, and the slippery condition of the roads, if they are not used at the proper time, makes them practically impossible to handle. We use road machines and drags that only require from two to six horses to pull, and when we get a light tractor of that capacity, then we will have an efficient steam or power machine to handle the maintenance problems for sand-clay roads, but as long as we have to put heavy tractors, forty to fifty horse-power, of eight to ten tons weight, they are too heavy and costly to use on roads as maintenance tools. Among the troubles in using a heavy machine, the bridges and culverts, as now generally built, will not stand them, but the light machines ranging from three to eight thousand pounds, and with a draw bar capacity of from four to eight horses, would, I believe, be a very efficient machine for economical maintenance, and, while I do not know of any developed yet which is a really effective machine, I believe that such machines will soon be on the market. With smaller machines, costing from \$500 to \$1,000, you can invest in four or more, say at the cost you now have to put into one of the larger kind, and thus keep four maintenance outfits at work at an investment cost no greater than is required for one of the large machines.

How is the maintenance done in Franklin County?

Four men and six mules have about sixty-five miles of sand-clay and twenty miles of other roads to keep up, and are doing some grade work in addition.

How do you arrange about dragging?

They have six mules, say, three drags, two mules to the drag. They go immediately after a rain and drag the road. Some of the roads have stood in good condition for a year without being touched, but local conditions control that entirely.

Is using farmers in different sections, trained to drag roads, a good method of maintenance?

If you have a man as superintendent in charge, held responsible for maintenance, and he is provided with automobile or other method, to see that roads are dragged promptly and properly, it should prove a good method in many cases.

Can two ordinary mules handle a drag?

If the mules are light, use a light drag. I would never advise a county to use a mule weighing less than eleven or twelve hundred pounds. The heavier mules can pull a pretty heavy drag, the heavier the drag, the better.

What is the cost of the outfit a year?

This cannot be answered definitely; perhaps somewhere around \$3,000.

LEE COUNTY.

By R. P. COBLE, Road Engineer.

Lee County has a somewhat peculiar condition. About three years ago they voted \$100,000 on property whose assessed valuation is five million dollars. A tax of 15 to 17 cents was levied on the \$100 worth of property, netting a revenue for roads of about \$8,000. Out of this, five thousand pays the interest on the bonds and about one thousand is applied to the sinking fund, a total of six thousand, and leaving about \$1,500 for maintenance of the roads. The total mileage in the county is about 300 miles. With that small amount of money, we cannot possibly get very far in maintaining the roads of the county. The bridges also have to be maintained out of this fund. Every \$100,000 additional bond issue on the county will require an additional

\$6,000 to take care of the interest and sinking fund. A levy of thirty cents will bring in \$15,000 a year; it will take \$12,000 of this money to take care of bonds and sinking fund, and the county will just have about \$3,000 with which to maintain the roads.

My experience with sand-clay roads is that they are not very difficult to maintain. The best method of maintaining a road is the split-log drag. I find that some of the road does not need dragging more than five or six times per year and some of the gravel roads have not been dragged a single time. The road machine has been over them a few times. The road from Sanford to Raleigh, about forty miles, was finished in February, 1913, and has not had \$20 spent on it since it was built. The surfacing material contains 75 to 80 per cent gravel and is good.

We have another piece of road in the county, about eight miles long that was finished about eighteen months ago and has had \$40 to \$50 spent on it. This road has had the machine used on it about twice. Some of the sand-clay road in the county has had no work done on it practically at all because it did not need it. Last year we cleaned out the ditches thoroughly, threw the material on the outside of the road and in this way eliminated all bad drainage propositions, and the roads at the present time are in fairly good condition.

Question: Did you examine the roads from time to time to see if they needed maintenance?

Yes.

Question: Were you keeping track of that road, so if you did have a bad place in it you could repair it or did you wait from one year to the next to do all that was necessary?

We had two or three bad places that should have been repaired. The trouble there is to find a man with experience to do this work. Unless I stop one of the foremen on the construction work and carry him back to do the work, it cannot be done. That is the trouble; to get a man with experience to do the work.

I am doing the dragging there by hiring farmers' teams. I give them about five miles each. They can do this in one-half day.

Question: How do you keep track of that?

I inspect roads from time to time and if I find a break in the road where there is not enough sand or clay, I have them haul sand or clay.

Question: What kind of gravel do you use?

White gravel.

CRAVEN AND WAYNE COUNTIES.

By R. E. SNOWDEN, Road Engineer.

I have not done much work in Wayne County. During the time I was there we have built two roads—the Pikeville and the Stantonsburg roads. We built these roads of first-class sand-clay construction, or possibly gravel construction with very coarse sand. The material was very close at hand. The roads were designed thirty feet wide ditch to ditch with twenty foot surface. We were compelled to do this owing to the heavy traffic just out of Goldsboro. This fall there was some misunderstanding between the road trustees and myself as to who was engineer, and I am not there any more, but during that time we completed these two roads. One of the trustees who lives on this road is very much interested in road maintenance. I keep in touch with

him at present though not connected with the job, and by a proper system of maintenance on these two roads they have held up almost perfectly during this wet winter. The type of drag we use is a combination of cutting and smearing drags. The front blade is vertical and sharp, shod with iron; the rear blade is in the shape of a trowel. The front is about two and one-half inches higher than the rear and we have found this drag very efficient in dragging these roads. In that way we have gotten an almost perfectly smooth and almost perfectly water-tight surface so far as water penetrating from the top through the bed is concerned.

Craven County road betterment is a very serious complication. We have 1,000 miles of road with about fifty or sixty miles of fairly well improved miles. Two years ago we began a patrol system of maintaining the roads. We were able to improve the roads very materially, but last June politics took control of the roads, and because we could not build at once by every man's house by our plan of work, they placed each township by itself under the supervision of three men in each township. That gave me twenty-four men to report to, twenty-one too many, so I withdrew from all road work in the county except the Eighth Township and the Central Highway through the county.

During the past year what politics did not do to the roads the wet weather has finished. I understand a bill has passed the present Legislature putting all the roads of the county under the supervision of one central plan. The Central Highway through the Newport pocoson was the only section in North Carolina not passable at all times of the year. I found it undrained, very flat and on black, peaty soil which was usually impassable. We improved this road by cutting large ditches and grading the edge off on the side next to the road and then hauling in soil from the savannah on each side of the pocoson, material known in that section under the local name of savannah soil, and covered the road to a depth of twelve inches. We dragged this road all through the fall and winter, and it held up very well during the wet season, much better than we expected. We find in working a road that is nothing but an earth road without any topsoil, that a great deal of good can be accomplished by cultivating the road just in reverse to the way a farmer cultivates his field—by getting out on a road and plowing while wet, to make a slop of it. In other words, you accomplish for the road what the farmer does not want to accomplish for his field, you make it stiff and hard and tight. Our greatest obstacles in the way of getting good roads in Craven County and a good many other counties in Eastern North Carolina is poor drainage and politics.

HALIFAX COUNTY.

By N. C. HUGHES, JR.

As a preface to my remarks on road work in Halifax County for the past year, let me say, that we are peculiarly fortunate in one particular phase of the work in general, and that is, that the business of building roads in Halifax County is, so far as I have been able to discern, free from the shackles of politics. But on the other hand, there has developed within the past year a condition, the effects of which tend to work a hardship on road improvement throughout the country as a unit. This is, that within the last year or eighteen months, two townships, Halifax and Enfield, have voted on and sold bonds for road building. This step has necessitated the appointment

of a board of township commissioners for each township separate and apart from the County Good Roads Commission, whose duty it is to look only after the expenditure of the bond money used in construction of roads. These townships still have a general county road tax, the disbursement of which rests in the hands of the Good Roads Commission of the county. Here, it is readily seen, lies open a chance for some conflict of authority, but to date all matters concerning the expenditure of the separate funds have been neatly adjusted. Yet it is also evident that so many organizations for the same general purpose entail greater expense in the administrative department, to say nothing of the liability of a disunited effort in properly systematizing general road work for the county.

Connected with this condition is one which sometimes works difficulties upon the superintendent, that of having to deal with three distinct organizations composed of a total of twenty-one commissioners, with each commission having to operate under different conditions and different problems. And coupled with this state of affairs, he has to meet another proposition with strong moral suasion and some degree of diplomacy, that of pleading with the county commissioners who have solely to do with the appropriations for equipment for the regular county road force.

But beyond all this, the main idea has been and still continues to be that of building roads and better roads. Since June, 1913, we have constructed or rebuilt upwards of fifty miles of roads, about seventy-five per cent of which are sand-clay and clay-gravel roads and the balance good earth roads widened and reshaped and well drained. The average cost per mile of the sand-clay and clay-gravel roads was approximately \$1,100, and that of the earth roads \$500.

So great has been the pressure and effort to construct roads throughout the county that comparatively little effort has been expended either to maintain what has been built or to institute any maintenance system. Yet we are planning to try out within the next few months a maintenance system in one or two of the townships which already possess some first class roads, and we hope to be able to make a good report upon this trial next year. I feel constrained, however, to make mention of one township that has made more effort and accomplished more results in maintenance than any other one in the county, and that is Roanoke Rapids Township. The system in vogue is to be credited to Mr. John L. Patterson, of Roanoke Rapids, chairman of the County Good Roads Commission, who is perhaps one of the broadest gauged road men we have, and who certainly is one of the most practical. The actual execution of the system is entrusted to a superintendent who has two mules with two dump carts and drivers and an extra man or two as helpers when needed, one drag and two drag scrapers. He uses the dump carts for long distance hauling of surfacing material, the team for dragging when needed, a mule to each scoop for cleaning out the roadside ditches and slipping convenient surfacing material on the road, and the extra help for loading, shrubbing, cleaning out pipe and cutting storm ditches. This outfit for the year around costs on an average of \$100 per month, and with good management covers a total of about twenty-five miles. This makes the cost per mile per year for maintenance about \$45. But for the fact that quite a bit of fairly good reconstruction work is done along with this work, the maintenance cost per mile per year would, I estimate, be about \$30. This system, of course, was used upon roads which were under the standard in width and grades and were

only old county roads that have been gradually built up by this method of maintenance. They have stood up remarkably well under the hard, heavy weather of this past winter, and are better than second-class roads in the open seasons. It is true also that virtually all of our newly constructed sand-clay and gravel-clay roads have stood the test where they had been completed before October. The results in the latter cases being due, I have concluded, to a very free and frequent use of the road machine instead of the drag for reshaping and redressing. Certainly the drag is an admirable tool, but it is truer still, from actual experience, that a well constructed road can the better be kept in proper shape and condition by the use of the road machine upon it at least once in sixty days or ninety days at most. The heavier the traffic the more frequent should be the use of the machine.

As a final word permit me to say that I do not believe this organization could be of greater service and benefit to the State than to gather facts and figures relative to the maintenance of roads from every available source, both within the State and without, from men who have made actual tests along this line and whose testimony could be relied upon, compare these facts and figures, with all the extenuating circumstances considered, and then have the whole compiled under the efficient supervision of the State Geological Survey, whence copies may be conveniently distributed over the entire State whenever called for.

HARNETT COUNTY.

By IRA B. MULLIS, Road Engineer.

The maintenance in Harnett County is, as in many other counties of the State, done under the old six-day labor tax system. Under the new law of 1913 any county or township wishing to build improved roads has the right to issue bonds to do the work in this way, and fortunately this law always says that when any township issues bonds for road construction the road commission must maintain these roads by the use of the split-log drag or some instrument to keep the crown of the road in a smooth condition, and if they fail to do this they are guilty of a misdemeanor and upon conviction shall be fined or imprisoned at the discretion of the court.

WARREN COUNTY.

By SAM D. SCOTT, Road Engineer.

Some days ago Dr. Pratt asked me to make a report for Warren County. The roads in the townships which have no bonds are built under the old tax system. It seems to me that under these conditions about the best thing we can do is to use the patrol system and that is what I use in the township in which I am working. It is our intention to get these farmers together on different stretches of road and teach them the use of the split-log drag, because I find that the majority of people know nothing about the use of it. We want to get these farmers to agree to drag the five-mile stretch of road that he travels most and we want to make him a patrolman; make it his business to look after his particular stretch of road and report upon it. We usually suggest that they have the following tools: A split-log drag or drag of some kind, a shovel and perhaps a mattock, and also a ditch cleaning apparatus. Sometimes I clean about six miles of ditches for about six dollars on both sides of the road. We want to get these men together and teach them the use

of these tools. The trouble is the farmers will drag the roads at the time most convenient to them. I recommend that each man report to his supervisor (since we will not have any superintendent of maintenance or engineer) and that these reports be made out on some form, perhaps postal cards. This form should contain the following items: Time of rain; at what time the road was dragged after the rain; how many trips he made on the road; distance he dragged, use of harrow. He should send in to the man to whom he reports at least weekly, if he drags that often. In this way the supervisors can keep after the man doing the dragging. It seems to me that we will get about the maximum efficiency under some such system.

GUILFORD COUNTY.

By J. A. DAVIDSON.

Guilford County never did much in the way of topsoil or sand-clay roads until a few years ago, when they began to build topsoil roads. Where we have been able to get a quantity of good material, the roads have been very satisfactory and have stood up reasonably well. When you come to the question of maintenance, that is done largely by township commissioners. In our system of county road work under the present law, we have township commissioners, three in each township, and they are supposed to hire a superintendent to do what is necessary and to keep him out on the roads to look after the road forces and to approve his bills monthly for payment. That has not been satisfactory at all. I think it is owing more to scarcity of labor in the rural districts in each county than anything else.

We have been scraping out the ditches with a tractor. I have always insisted on the township commissioners putting their forces after this tractor to distribute the debris and fill up the holes after the tractor and in very few instances did we get anybody to do the work. I think the superintendent or the fellow who did the work on the roads would have to run down the commissioners and get them to approve his bills. It was very unsatisfactory and this feature of the work has been abolished, and now we are going to inaugurate a system of repair forces of convicts to be placed in different sections of the counties, which I think will give better results.

NEW HANOVER COUNTY.

By R. A. BURNETT, Road Superintendent.

You called on a bad man to make a talk. I am not much of a speaker. Gentlemen, you all want me to tell you what we are doing. The first thing we do in regard to maintaining roads is to see that they are all drained and the water kept off. The next thing, we have an automobile truck to keep stuff all along the roads throughout the county. We then have a maintenance gang that keeps the ditches clean and after every rain these people know where to go. They start out to find bad places and first get material like the road is built of to fill the holes with. If the hole is very deep, we use a lime rock, which we put in while the road is wet and on our roads there is a kind of mortar which will form a strong binder when mixed up by traffic. That is the way we are trying to maintain our roads and they are in first-class condition, and we have not had any trouble with our main highways this bad weather.

New Hanover is practically the only county at the present time that is

really carrying out a plan of systematic maintenance work largely by the patrol system. They have put in vogue the plan that the French have used in the maintenance of their roads.

MR. PRATT.—For the last two years since Mr. Burnett has started the systematic maintenance, he is getting splendid results. His maintenance charge is lower than any of you for a similar type of road. The system, however, can be used just as advantageously in other counties as in New Hanover and it is the only way I believe in the end by which you will get the best results from maintenance.

There has been considerable discussion about the maintenance of macadam roads and some think that the policy of just spreading stone on the road and letting the traffic pack it in was a bad idea, but I would like to ask if the stone he uses is not one with a high cementing value. I would like to know just what his stone is.

Answer: I cannot tell you what kind of stone it is.

I wish it were possible to follow a similar system in practically all the counties of North Carolina, whether macadam, sand-clay or gravel. If we could work out the principle of the system used in New Hanover County we would get satisfactory results in other counties.

REPRESENTATIVE FROM ROCKINGHAM COUNTY.—I have no report except by observation and it seems that our county is suffering from an overdose of politics. The first thing the new commissioners did was to turn off the best road man they had.

GREENE COUNTY.

By J. ROY PENNELL, Road Engineer.

This county tried to vote bonds about a year ago and failed, and then voted bonds by townships. They thought each township would get a better show. They voted \$110,000 of bonds and let it by contract. We have just been spending that and have about sixty-seven miles of road built and have spent just about one-half of the money. There are four contractors in there, who will finish in twelve or fifteen months. We are building sand-clay and topsoil roads. We have not enough clay there to furnish a good base for topsoil, but we have plenty of natural earth roads. The sand is almost too fine to use. In regard to maintenance of sand-clay roads, one reason that they have gone down is poor air circulation. What we are doing down there is to cut down every tree that shades the road, every tree except in a man's yard. It lets the sun in to the road, dries the road out and lets the air circulate through there. In a good many places we have had trouble this winter, especially where we put fresh dirt in and it held the water and in other places where new material was put in mud holes which absorbed the water, instead of getting off the water first and then putting in the material.

Question: Have the townships made any special arrangements for a maintenance fund?

None whatever. It will take us about five months longer to finish up the money and I have been trying to get them to put in a patrol system down there. The type of road we are building will be worth very little without maintenance and a good many of the people seem to realize that now.

YANCEY COUNTY.

By WYTHE M. PEYTON, Road Engineer.

As I understand, the question to be particularly discussed today is maintenance. That is something we in Yancey know nothing about. I cannot tell you very much. Yancey County, I will say for the benefit of those who have not been there, has never had any roads. As I heard a traveling man say yesterday, he came into the county about a year ago, had to drive up to the courthouse, and drive back again and he said if he could ever get forgiveness for that he would never try it again. I think many of us will feel the same way. In those mountainous counties the trails, I will call them, which we have there are very steep, very rough, in many places dangerous, so that the Legislature, at its meeting two years ago, was kind enough to take into consideration that the people of Yancey did not know what roads were, did not know the value of them, and they took it upon themselves to authorize an act embodying a commission and authorizing this commission to issue bonds for \$150,000, which was done about a year ago. For the last twelve months I have been laboring on the economical expenditure of that amount. We have been building our grades through that mountain section over the ranges of the Blue Ridge, many five hundred feet higher than Asheville. Our main traffic line is about twenty-three miles long. You road men in the Piedmont and eastern sections no doubt will think that 5 per cent is an excessive grade and unreasonable, but the people of Yancey County who have been traveling over roads, some of which have a grade of 23 per cent and over, think it is almost marvelous to get a 5 per cent grade. Then on our spur or tributary lines we are maintaining a 6 per cent maximum grade. Then as for width, we have one mile of thirty-foot road from the town to the station, but only twenty-six feet through the county as two years ago compared with about twelve or fourteen feet, and occasionally a little bit wider. It is certainly a great improvement.

Now a large proportion of this construction work has been rock work, approximately 50 per cent. We have completed about twenty-three miles and have about twenty miles more under contract which we hope to build if our money does not give out. At present we have only spent about one-half of the issue.

Now, for the maintenance. As I said just now, for the trails we had in our county the old labor tax of six days or six dollars. Each able-bodied citizen between the ages of eighteen and forty-five years was required to put in at least six days or pay six dollars for the maintenance of roads. This work was done and is being done under the supervision of a township superintendent from each of the eleven townships. I am glad to say a few of these men are pretty competent, but in most cases are inexperienced men and the major portion of the money is wasted. I would like to see a better system organized. Furthermore, for the future maintenance of our roads we have a fifteen-cent levy, which amounts to about \$2,000 a year. As we have very little of our road graded and none surfaced, we at present have just the old dirt road to maintain, which we are doing with the old common split-log drag.

STOKES AND ROWAN COUNTIES.

By C. M. MILLER, Road Engineer.

Some men build roads and go somewhere else and build other roads, and leave their maintenance to the tender mercies of some moss-backed Democrat

or Republican, as the case might be, to maintain. Of course, you know the results. As I get older I am satisfied that the engineer who simply builds roads and does not take some steps towards getting these roads maintained is guilty almost of negligence. It is the most important part of the work.

In Stokes County three townships voted in all \$140,000. In Walnut Cove Township they appointed a nonpolitical board of highway commissioners—two Republicans and one Democrat. The two Republicans took the bit in their mouth and went on with it. They did employ an engineer, and the result was we got about forty miles of well-built road. It is true sometimes I took the bit in my mouth a little. Unfortunately the bill did not provide for a dollar of maintenance. It provided for a sinking fund. I had planned and I had the consent of the board to reserve from \$500 to \$1,000 of this money for a maintenance fund. When they found there was a change not only of commissioners but in politics, they decided to put out every dollar of that money in construction. The result is, the roads have not been bad during the winter. They stood up remarkably well. I was only employed to build these roads, and as soon as they were built my work was finished, in a business sense, but in a moral sense I feel that I have done very much like a man who will build a house and not provide a roof over it. We hope to get a bill through, and I think it my duty to help get the bill through the Legislature, providing for the maintenance of these roads.

In Mount Airy we have a model Highway Commission. They tell the engineer what roads to build and expect him to do the work; in other words, he is boss of the job, not only of the building and construction of these roads but of the maintenance. We have, however, a superintendent in only one township. He has on outfit of mules and does a good bit of topsolling. Our roads are sand-clay. His duty is to watch these roads, fill up the holes, keep drags running and his road machine also.

In Rowan we have just lately organized what I believe is one of the biggest road maintenance systems that I have been connected with. In the first place we have an engineer. Under him we have a general superintendent, who has supervision not only of the construction but of the maintenance of all the roads in the county. The engineer makes the surveys, plans his roads, bridges, issues instructions to the superintendent, etc. He further confers with the superintendent in regard to the best methods of building these roads and of maintaining them after they are built. Under this superintendent we have two chaingang camps well equipped with the latest machinery suitable to our wants. In charge of these camps we have a foreman, who goes from one camp to another and looks after the maintenance work. They do the heavier part of the work. Then we have a patrol system, having men in the township connected by 'phone. This superintendent 'phones them when to go over their roads.

Another beauty about our work is that Rowan is a Democratic county, but we have no politics in our road work. I really do not know what the politics of our superintendent is.

EDGECOMBE AND COLUMBUS COUNTIES.

By J. W. MARTIN.

I have been in Columbus for the past fifteen months, and we have done some pretty good work during the past year. We have built about thirty-five

miles of good dirt road, but not much sand-clay. The material around there is not as good as in some counties. It is a low, flat country, a good deal of quicksand. We have built some few miles of pretty good sand-clay roads. The main road we built over there was from *Whiteville to the South Carolina line*. That road, if maintained as it should have been, would hold up and be a very good road during most of the year. They maintain the roads by working six days in the year. They either work six days or pay three dollars, which does more good. Besides building thirty-five miles of road, we have graded a great deal more road than that. They are behind now with their road work. They have had convict forces for several years, sometimes as many as seventy convicts. My average has been thirty-five during the past twelve months. I feel that the good piece of road we built last year has brought new life into road business in that county.

Edgecombe has a pretty good outfit now. We have been working roads in Edgecombe a number of years by taxation and by convicts; but our road building there has been more patch-work than building roads. We never attempted to build any good sand-clay roads until the last two years. I think the first piece of sand-clay road that was ever built there was about five years ago, but for the last two years we have been trying to do better work and the prospect is we will do better than we have done. We have two convict camps, about forty convicts in all. We had Mr. Fallis over there and we have done very good work and the prospect is we will do better in the next twelve months. We have a bond issue there of \$100,000 for roads and bridges.

DISCUSSION.

MR. PRATT.—From the remarks of Professor Strahan and Mr. Fallis; Mr. Snowden in regard to roads in Craven and Wayne counties; and Mr. Brown in regard to roads in Orange County, we find that sand-clay or topsoil or gravel roads have in many instances in all of these counties been bad during the past winter. As Mr. Brown said, there are undoubtedly reasons and good reasons why these particular sections of road in each of these counties have gone to pieces. Reasons will do for a certain length of time with some people; but it seems to me that the points which have been brought out this year have shown first that one of the errors—largely of the people themselves—is in regard to the cost at which they expect to build the sand-clay roads, meaning sand-clay, topsoil and gravel. We have too much of an idea that a sand-clay road is a cheap road, as far as cost goes, and that you can build a road anywhere from \$250 to \$500 per mile. Now it is absolutely impossible to make any statement whatever to any community or county regarding what a sand-clay road will cost in that community or county without making a complete road survey of the county or community; because the factors that enter into the cost of that road are not only the grading, but location of the road and the obtaining of suitable material with which to build or surface the road after you have graded it. If you have got to move that surfacing material a mile, compared with one-half mile in another section, it will make the road surfacing cost a great deal more. The people are asking us to build the roads too cheaply.

To my mind one of the qualities that you men here, representing the road builders present, must display in road work is to insist on thoroughness, not only in location but in every phase of the road work. That is going to be hard, because as Mr. Stacy has brought out, the minute the people have voted

bonds or placed upon themselves a considerable tax with which to raise money to build roads, they want the roads all built at once.

We have been carrying on considerable educational work throughout North Carolina regarding road construction. We have got to carry that still further now and show that in the end the best results not only to the road but to the people themselves will be not to hurry that work but to do it thoroughly and carefully, so that every mile of so-called improved road is made in the very best way it can possibly be done. If that had been carried out in all the counties, we would not have the reports we have had this morning in regard to sand-clay and topsoil roads.

In speaking about the selection of road materials, by simply going out and looking at it, reminds me very much of the way many a mine has been examined and reported on in the western part of this State. Instead of having an assay of the ore made, it was just looked at. I have a splendid illustration of that: I was called from here to New York and went over a proposition there. They had a little over one million tons of ore blocked out that they said would average $5\frac{1}{2}$ per cent copper. I asked them how they had determined it. They said, our superintendent has kept track of the ore and we know we have it. After my examination I found that they had practically blocked out about 1,500 tons of ore and had packed this ore. The way that it had been examined it looked like good copper ore. They picked out occasionally a piece of ore that they knew was copper ore, had it washed and it did carry a good per cent of copper. The million tons dwindled to something like 1,500 tons. The same precautions must be carried out in regard to road materials; you have got to have, first of all, a man of some experience and who knows about road materials. You must from time to time make tests of the materials to know if you are getting something good. You must be thorough about the selection of road materials. The whole difficulty we are now experiencing summed up is lack of thoroughness in the selection of road material, and in the method of putting the material upon the road. It may perhaps have been put on too late in the season when it had no chance to get thoroughly mixed and hardened before the rainy season came in.

MR. D. TUCKER BROWN.—I do not know that I can add anything further to what has been said in regard to the construction of a sand-clay road. In the details of construction, I find in the State of North Carolina that we have had failures in each of the counties. I am more familiar with the western part of the State. In the eastern part of the State it is hard to obtain clay and in the western part it is difficult to obtain sand. In Buncombe County they have a good deal of macadam road. They concluded it would be better to build their minor roads of sand-clay and the main traveled roads of macadam. Recently they have concluded it was better to resurface their macadam roads with some bituminous material and continue to build minor roads of sand-clay. In the construction of these sand-clay roads, they have had nobody who knew any thing about it. They had no engineer and they went about it in a haphazard way with not very good results, I understand. They put two things together, sand and clay, ran a harrow over it, and in dry weather it would look well. But during this past winter these roads have been very deep in mud. The people have come to the conclusion that these roads are failures. I often find that where these roads have not been supervised by a man who knew what he was doing they have been failures.

Dr. Pratt was speaking of Henderson County. Last year they put sand on

top of clay and left the roads for the traffic to mix. These roads were as disagreeable in summer with dust as in winter with mud. The failures in sand-clay roads built in this State are largely due to faulty construction, poor judgment in choosing materials, etc.; but I find that lots of times where a road has been built properly the maintenance fee comes in to be considered, and we have just got to get some way to maintain these roads. The cost of maintenance is a small item compared with construction, but a better system of roads will result in every county if the roads are properly and constantly maintained. I think where roads are constructed by engineers who know what they are doing and what materials they are using, that they hold up a great deal better and are easier to maintain than those built by men who go ahead in a slipshod way and call it sand-clay building.

MR. SPOON.—It has been my duty to look after roads from Fayetteville, N. C., to Cheraw, S. C. On this stretch of road I have almost every condition of sand-clay road construction. This is one thing I know from observation. A light, even cheaply built, sand-clay road constantly dragged will stand a more severe traffic than the more substantially built sand-clay road unmaintained. Mr. Tufts, who has charge of the roads in the community of Pinehurst, has, in my judgment the weakest sort of sand-clay mixture, yet it never rains that the roads are not dragged, and these roads are thus kept in good condition. There was a sand-clay road built from Rockingham north to Jackson Springs. The construction of that road was very cheap; clay was spread on the road and then a road machine was placed on that, and some more sand poured on to counteract the excess clay in it. A drag was immediately put on that road to be used every time the rains came. I passed over that road not many days ago on one of the rainiest Sundays we have had this year, and I made a speed of twenty miles an hour on that road, and very few feet had mud on it. I want to say that I know the remedy that kept that road up under such conditions was nothing more nor less than faithful dragging.

Now I want to say in relation to the sand-clay road, that the failure of the sand-clay road in North Carolina is due to two causes:

First. An incomplete or improper mixture.

Second. To neglect.

We need, my friends, supervision, intelligent and constant, and at the critical or right time. A sand-clay road that will stand as a sand-clay road must have attention at the right time, which is just following a rain.

MR. PEYTON.—When should the road be surfaced or sanded? Is it better to allow your new or crown grade to settle awhile? I am rather of the opinion that it is, because necessarily there are places which must be patched before putting on your surface of sand-clay.

MR. STACY.—If you take care of the traffic that will settle it.

MR. PRATT.—That is one of the questions—whether or not after constructing the higher fills, those fills will necessarily shrink—should you take care of that shrinkage on a percentage basis, and put your finished surface on it, or will the shrinkage break the crust of that finished material, or will the finished material go down gradually with it? That is the point I want to bring out.

MR. FALLIS.—I am inclined to think that the sand-clay should be applied as nearly as possible behind construction work. You cannot take care of the traffic on a newly built, especially a sticky, red clay road, for any distance

if a bad rain comes up. If there is any chance for a rainy season the road will become absolutely impassable and cause more trouble than can possibly result from the drainage of a fill. I would always build a fill sufficient to take care of shrinkage, provided the fill was not beyond the maximum and the shrinkage of the fill would make my grade excessive. I am of the opinion that I would always keep my sand-clay or topsoil just as closely behind the other construction as possible. There is another reason for this, and that is your outfit and camp make it more economical to finish your work close as you go.

MR. PENNELL.—The only objection I see to putting it on right after construction work is in going up to a bridge abutment. It will settle there and break while it is green, but it is very easy to have that fixed and new material put on after the balance of the road is completed. My experience has been that it is much better for the traveling public and more economical for the county to do the work while grading is going on and if it settles over stump holes, etc., pick up those places that have gone down, add new material, and your wearing surface is just so much thicker.

Question: At what time is it better to drag a sand-clay road, immediately after it rains, or wait till it dries?

MR. SPOON.—The sand-clay road should be dragged as soon after the rain has fallen as you can. I want to be clear on this point. A road that is not a sand-clay road has no business to be dragged then. A clay road should not be dragged in a rain because it sticks and lumps; but when a sand-clay road has the proper composition, there is not enough clay there to give it this lumping quality. The excess of water that happens to remain there in the depressions is very probably taken care of by the drag, bringing in new material and forcing the water out. As soon after a rain as possible a sand-clay road should be dragged.

Question: What weight of drag do you recommend?

I would not advise an extremely heavy drag. I use a wood drag of sufficient weight to hold steady with two or three mules, then additional weight ought to be a movable quantity, because many times you want to so transfer weight from one point to another to make a deposit of material where necessary to keep the road smooth.

MR. FALLIS.—I want to say in reference to the failure of sand-clay roads this year, that more miles were constructed during the past six months than ever before. The facts are that we had less rain in the months preceding December and January than during such a period for two years; consequently many of the roads throughout the country had never been wet or mixed, and this is the first time in their history that they were ever thoroughly mixed, so they went down. The only thing we need now is to work faithfully till we get them firm and shaped up during the spring, and we will never have this trouble again.

Question: Do automobiles help roads?

MR. SPOON.—The Pinehurst roads are the finest, most ribbon-like roads I know of, and if subjected to traffic, such as that on the roads leading to Durham, Raleigh, etc., they would not stand up. But we do have one or two motor trucks that go over these roads every day and they are standing up.

MR. DAVIDSON, OF GUILFORD COUNTY.—We have about one thousand miles of public roads and we have over three hundred miles of improved roads. I am county auditor, and in addition am general supervisor of roads. I have en-

joyed this discussion and I think we have all seen the difficulties we labor under owing to different conditions. There is one thing we have got to work out, and that is the manner of maintenance after we have built the roads. In my county we had a road law appointing three commissioners in each township. We spend about \$11,000 each year in those townships, and those commissioners hire what they call a foreman who goes out and does the work. They O. K. his bills. They come in and the board of commissioners pays it in each township. It has been a failure almost completely. It is hard to get a responsible fellow to do the work. We have got to work out some way of keeping up those roads, and I have been after our board of commissioners to get a practical motor truck with a maintenance squad for improving roads. We can put a half dozen convicts in it, go to the road needing repairs, and get back to the jail that night.

WEDNESDAY AFTERNOON.

DR. PRATT: The first talk on the general subject of bituminous material will be made and illustrated by Mr. Frank Whitfield, representing the Barber Asphalt Company.

Use of Bituminous Compounds in Road Construction

BY FRANK M. WHITFIELD,

Representative of the Barber Asphalt Paving Company, Philadelphia, Pa.

Our director has chosen a very hard subject for the subject on which I am to address you. It is hard due to several reasons. First, because there are so many branches to bituminous compounds. To bring this down to a basis where we can more readily understand the subject to be discussed we will call it "Asphalts in Use in Road Construction."

Asphalts are divided into two classes, viz.: The Natural Lake Asphalts and the Oil Asphalts or Artificial Asphalts.

First, we will take up the soil asphalts and will look a little into them. Some years ago the only oil asphalts in use to any great extent were the residues from the distillation of crude oil found in the California oil fields and which were sold under the trade name of California Asphalts. Prior to placing these on the market, refiners of crude oil used to haul these so-called asphalts out to sea and dump them into the water. Then a chemist came along and advised the refiners that the residue "looked like asphalt, smelled like asphalt, and had some of the characteristics of asphalt," so they put this residue on the market for sale in road building.

Later on oil asphalt was obtained from the distillation of crude oil found in the mid-continental oil fields, from the Texas oil fields and from the Pennsylvania oil fields. These residues from the distillation of crude petroleum were placed on the market under various trade names, such as Texaco, Standard, Sarco, etc.

Then about three years ago several companies commenced importing crude petroleum from Old Mexico, from the oil fields around Tampico, and are now placing on the market the residue from the distillation of this oil under various trade names, such as Texaco, Aztec, Montezuma, etc., and the use of the oil asphalts from the distillation of crude petroleum from the mid-con-

tinental, Pennsylvania and Texas oil fields has almost ceased. There are many reasons for the discontinuation of these oil asphalts in road construction, the main reason being that there were numerous failures of these materials due to their non-uniformity and failure to withstand severe "service tests" when placed in streets and roadways. The oil asphalts from Mexico have as yet to demonstrate what they will do, as no streets in the United States constructed with these asphalts have been down over two and one-half years.

Now we come down to the class of asphalts that are REAL, and they are the asphalts which I have the pleasure of representing before you today, Trinidad natural lake and Bermudez natural lake asphalts—the only two natural lakes of asphalt known to the paving world today that are used in various methods of road construction.

First, we will take Trinidad. Trinidad natural lake asphalt comes from a natural lake of asphalt located near the coast on the Island of Trinidad in the British West Indies. This lake of asphalt has no doubt been exposed in its natural formation to the winds, heat and storms for hundreds of years—no one knowing for just how long—but it is said that the inhabitants of Egypt used Trinidad Lake asphalt for embalming their dead and that Noah's Ark was made water-proof with Trinidad natural lake asphalt. (Laughter). However, be that as it may, we do know from our experience that Trinidad is the father of asphalts, and we have streets constructed in the United States with Trinidad asphalt which have been in actual service for over thirty-five years with a very small maintenance, and hundreds of thousands of square yards which have been down over twenty years and are still giving excellent service. This service "test of time" under varying traffic and climatic conditions has proven beyond a doubt what genuine lake asphalt from Trinidad will do in road construction.

Now we come to Bermudez natural lake asphalt. Like Trinidad it is a natural lake of asphalt, but is located in the State of Sucre, Republic of Venezuela, South America. This lake of asphalt, like Trinidad, has no doubt been exposed to the elements for hundreds of years until, through a natural process in the course of time, it has refined itself, like Trinidad, and the company I represent is offering these two natural lake asphalts to the city and county officials of the United States and other countries for use in building good roads and streets.

In addition to offering you these two natural lake asphalts for use in road construction, we are backing our offer up by our over thirty-six years experience in the paving business, during which time we have gone clear through the "experimental" stage and have kept on from year to year importing and selling Trinidad and Bermudez asphalts under their own names, and have not tried in all this time to palm something off on city and county officials which we believed "as good as" the natural lake asphalts, and all the time our business has continued to grow and expand until we have Trinidad and Bermudez laid from Canada to the Gulf and from the Rockies to the Atlantic Coast, under all kinds of climates and traffic, and our business has increased every year—surely proving beyond doubt that we have materials in a class by themselves and which, so far, have never been successfully imitated except in color.

I have with me several reels of moving pictures showing the lake asphalt industry, and if you will give me your attention for a few minutes I will run

these pictures through and show you by motion pictures how Trinidad and Bermudez are mined, refined and used in road construction.

First, we have a view showing Trinidad Lake, showing the natives picking the asphalt from the surface of the lake. This is picked out with ordinary picks, loaded into the cars you see in the picture and transported on the small track you see in the picture to the docks; the buckets into which the asphalt is loaded on the cars are then picked up by an overhead cable and carried to the ship alongside the wharf and dumped into the hold of the ship.

Next, we will take a look at Bermudez Lake. Like Trinidad, the asphalt is picked from Bermudez Lake. You will note the men work sometimes up to their waists in water. This asphalt is also loaded on small cars, and from these small cars, is placed on flat cars and transported to the dock by railway—Bermudez Lake being located about seven miles inland. Notice the shape of the pieces loaded into the buckets, and then notice the asphalt as it comes from the buckets. It has naturally welded together in transportation. I might add here that it was considered quite an engineering feat to build this railroad which you see in the picture, as it goes through practically an impenetrable swamp.

Next, we see the train arriving at the dock and the asphalt being loaded into the hold of the ship. Notice that the asphalt has again welded together in the shape of the buckets into which it was loaded. Now the boat proceeds down the Gulf and into the Atlantic and on to our refinery at Maurer. Then we see the men picking the asphalt from the hold of the ship as it has welded together in transit. The asphalt is then placed in open stills and heated to about 350 degrees F., in order to remove the water and debris that naturally accumulates in the asphalt as it comes to the surface of the lakes. I want to add here that in this manner of refining is where the natural lake asphalt has one advantage over the residuals or oil asphalts, in that we refine it at low temperatures, whereas the oil asphalts are often heated to as high as 1,000 degrees F., in order to get the high-priced oils out, out of which the refineries make their great profits. Next you see the asphalt being drawn out into the barrels, which are first clayed in order to prevent the asphalt sticking to the barrel. It is then cooled and is ready to ship to various parts of the world to be used in road and street construction.

While some of you gentlemen may not be so interested in street paving as in country road paving, I am going to show you next just how sheet asphalt pavements, the highest class paving known to the paving world, are mixed and laid.

We see in this reel the asphalt being loaded onto barges, this particular shipment being for a coast point. Next, it is being unloaded at the paving plant of the contractor. This picture is a municipal stationary plant. The barrels are cut open, the asphalt carefully weighed and carried to the stills where it is fluxed; that is, mixed with a fluxing oil in order to make it of the proper consistency for use in mixing with the mineral aggregate of the pavement, making what we term an asphalt cement. We next see the plant making the binder course for the pavement, that is, a mixture of stone, sand and asphalt cement, which is used to form a bond between the wearing surface and the concrete base of the pavement. This is carefully weighed and mixed and hauled to the street in bottom dump wagons as shown in the picture. We next see the concrete base being laid, this base being six inches in thickness. The concrete base for a pavement varies in different localities—the

character of the traffic it is to be subjected to and the subsoil being guides as to what depth to lay the base. The concrete base is mixed in an approved mixer, same being composed of sand, stone and Portland cement, the usual proportions in our territory being one part Portland cement, three parts sand and six parts stone or slag—one part being equal to four cubic feet. Next we see the binder course, which we just saw being mixed at the plant, being dumped on the concrete base. This binder course is then raked and rolled with a steam roller until thoroughly compacted.

We will now go back to the plant for a while and see them mix the sheet asphalt or the wearing surface. In making the wearing surface, sand is carefully graded from 10-mesh up in order to get as few voids as possible in the mass; it is then run through sand driers and into the mixer; then the filler, which is either limestone dust or cement, is added to the hot sand cold, and the entire mass is then mixed with the hot asphalt cement, the asphalt cement being about 350 degrees F., when mixed. The mixing is kept up in a pug mixer until all particles of the mineral aggregate are thoroughly covered with asphalt. It is then dumped into bottom dump carts, the same as the binder course, and hauled to the street, where it is dumped onto the binder course and raked and thoroughly rolled with a steam roller, after which cement or limestone dust is swept over the surface to take off the black appearance of the surface, and the street is then open to traffic, and you see in the picture the highest type of pavement known up to the present time, provided it is made with natural lake asphalt.

We see next a view of Fifth Avenue near Forty-second Street, New York City, acknowledged to be the heaviest traveled thoroughfare in the Western Hemisphere. You get a fair idea of what this tremendous travel is from the picture. A pavement laid on Fifth Avenue with Trinidad natural lake asphalt withstood such traffic for nineteen years before being taken up, and the stretch was relaid with Trinidad. This is proof beyond a doubt of the lasting quality of natural lake asphalt.

We will next look at a bituminous macadam pavement, mixed method, which is the highest class of pavement for country highways, and I might add that sooner or later we in the South are surely coming to the improved hard surfacing of our highways, as it is a foregone conclusion that plain water-bound macadam is a thing of the past and the ordinary roads are fast disappearing. We see here what we term a typical country road. Notice the badly rutted surface of this earth roadway and how difficult it is even to go over it in an automobile. Next we see this roadway being excavated for the base. This picture explains itself. We next see them dumping stone for the foundation on the road. Broken stone foundations are used on a great many country roads, as it cheapens the cost of the roadway. The base is then thoroughly rolled with a steam roller, and if any uneven or soft spots are noticed new stone is added, and the rolling is kept up until the surface is solid and the stones do not creep in front of the roller. We next see what we term a portable plant, that is, a plant which can be moved to a point near the country road to be paved. The carefully graded stones of the bituminous mixed macadam roadway are mixed with the hot asphalt cement and the entire mass mixed in a pug mixer until all the stones are covered. The top is then hauled to the roadway and spread on the broken stone base in much the same way as the binder course of the sheet asphalt pavement. It is then rolled until thoroughly compacted with a steam roller. Over the top of this is then

spread a seal coat in order to make the roadway absolutely impervious to water and close up any small voids in the surface. This seal coat is one-half gallon of hot asphalt per square yard, and over this is spread pea grit and the surface then thoroughly rolled, and the road is then ready for use. You will notice in the picture the kind of travel over this roadway after being paved with bituminous macadam by the mixing process. Such a roadway will surely prove a lasting investment to a community especially if built with Bermudez as "Bermudez stays put."

On our next reel we see what we term the resurfacing of an old water-bound macadam road by the penetration process. First, the old macadam is torn up with a scarifier and the sub-surface rolled. On top of this is placed stone one and one-half inches in diameter. This stone is raked to the grade of the roadway and left porous. Next, there is spread in this stone hot Bermudez asphalt heated to about 350 degrees F., to the amount of about one and one-half gallons per square yard of surface. This hot asphalt penetrates down into the inch and a half of stone and thoroughly coats the stones. There is then spread over this stone screenings about five-eighths inch in diameter and the road is then thoroughly rolled with a steam roller, forcing the stones of one and one-half inch dimension thoroughly together, and also forcing some of the five-eighths inch stone into the voids between the larger stones. This rolling is kept up until the road presents a smooth surface. Next is added to the surface one-half gallon of hot asphalt per square yard, and immediately over this is spread stone chips of about five-eighths inch dimension, and the road is again thoroughly rolled. This last course is what is known as the seal coat. The road is then open to travel. This class of roadway is very economical for country roads; is easily repaired and is rapidly gaining in favor wherever used. Buncombe County of our State is going to build this year some 100,000 yards of this class of roadway, and once started I feel confident that other progressive counties will discard the old temporary road building methods and build hard-surfaced permanent roads which are always the cheapest in the long run. When such roadways are built of the tried-and-found-true Bermudez they will last a great deal longer, as "Bermudez stays put."

Now, our last reel is one that is especially interesting to you gentlemen who have any water-bound macadam or gravel roadways that are showing signs of disintegration. This reel will show the surface treatment of such roadways with Trinidad liquid asphalt. We will go back to the island of Trinidad for a few minutes in this picture. We see here oil wells which were drilled by our company around the edge of Trinidad natural lake of asphalt. At a certain depth we struck a natural flow of asphalt in a liquid form, and you see in the picture the liquid asphalt flowing out of the wells and into holes in the earth, as when we first struck this liquid asphalt we had no tanks built and had to take care of it in these earthen tanks. This Trinidad liquid asphalt is brought into this country in tank steamers and is then shipped to various points of use in tank cars. We sell this Trinidad liquid asphalt in two grades—our Trinidad liquid asphalt "A" being for cold-surface treatment, and our Trinidad liquid "B" being for hot-surface treatment. All of our tank cars are equipped with steam coils for unloading, and we see in this picture the tank cars being unloaded into distributing wagons. The method of treating old macadam or gravel roads with Trinidad liquid asphalt is to first sweep the road surface cleanly with a horse-drawn broom. Next

is applied about one-half gallon of either the cold or hot material, whichever is accepted, and then immediately, as shown in the picture, stone chips are swept over the road, so that about a cubic yard of screenings or stone chips will cover about forty square yards of surface of the roadway. The roadway is then rolled—although with the cold treatment this is not absolutely essential—and the surface should be kept barred from traffic for about forty-eight hours. The roadway will then be ready for use. Such a treatment for a roadway is very economical, and when Trinidad liquid asphalt is used it forms a truly asphaltic surface, impervious to water, absolutely dustless, noiseless and very durable. This treatment should be repeated in about eighteen months, and eventually you will find after about three treatments you have built up a thick asphaltic top which will give you years more wear, and the whole treatment has been exceedingly economical.

Now, gentlemen, one word more and I am through. Get right in this road building. Build good, solid, lasting asphalt roadways and use good natural lake asphalt in such construction, and after a few years you will find that you will not have to assemble here each year and try to determine the kind of roadways to build, but will assemble for the purpose of advising others how stable and lasting your roadways are, and when the heavy rains come, as we have had in the past two months, you will not have to lie awake nights figuring on how many miles of roadway you will have to rebuild, patch, etc., but will be secure in the fact that your road will be there in the morning ready for use, for "Bermudez stays put." I thank you and would be pleased to answer any questions I can, either here or while I am here in the city. I can always be reached for consultation on the question of road building in my office at Atlanta, Ga.

Specifications: A Discussion of Their Importance in Road Building

BY BRENT S. DRANE, Consulting Engineer.

Several times in the past it has happened to me, gentlemen, when I have attended conventions like ours now, expecting to gather valuable ideas on some subjects set for discussion by men eminently qualified to handle them, I have come away disgusted; the men who had the experience spent too much time in proclaiming their eminence and the things they could do, and too little in telling the rest of us how we could do those things better.

That has made me timid in setting myself up like this; and I am going to ask two things of you: First, to understand that if I shall seem to recommend technical men, I am not talking about myself; and second, to charge my dryness partly, at least, to my effort to deal in facts to the exclusion of personal fancies.

"Contracts and Specifications" is the subject you have assigned me. I shall ask you to let me reverse the order, and take up specifications first.

"Specifications" is a word unfamiliar to the average man until a graduate lightning-rod agent undertakes to sell him an automobile; he then gets sick of the sound of it. I shall therefore not take an automobile as my text, but a wagon.

If one of you should be going to buy a few wagons for road work, you would, I believe, consciously or not, use a considerable amount of care and first-class judgment. First you would decide to fit your funds and the class of work before you, what *kind* of wagon you wanted, whether slat-bottom or dump-body. Next you would consider, in deciding on the particular make

you would buy, (1) how it would *pull*, involving its weight, the tire width, its length of coupling; and (2) how it would *last*, involving the material used in it, both kind of material and grade of material, and size and thickness; and most particularly the way in which it is put together.

You would probably decide, on the basis of your own observation and experience, the best way, if you have had these; or, if you had not, then you would be guided by the judgment of somebody whom you knew *had* had experience that seasoned his judgment, and who had no personal axe to grind, and would advise you honestly and for your best interest. In that case you are apt to get something which *experience* has proven to be honestly *constructed* on the right *principle*.

Now, there is right much in common between the way in which you would get the most out of spending five hundred dollars in wagons and out of spending five hundred thousand dollars in roads. What has made the particular wagon you bought worth your care and judgment in its selection is, first, the best *specification*, and, on top of that, honest *construction*.

A specification is nothing more than a set of principles laid down clearly and unmistakably, which have been evolved from, and which embody the results of, long and costly experience in the kind of work they cover. The factory that made your wagon, after having the benefit of the general experience of the ages in evolving wheeled vehicles, has probably spent many thousands of dollars on its own hook in costly experimentation, in arriving at the specification which to its managers seemed just right.

Similarly, the world has spent billions of dollars of wasted money—enough to put asphalt pavements on concrete base over all the highways all of us together ever saw I do not doubt—in learning how to build the best road for the money. Manifestly, in coming to a decision as to how to spend our road money, we should not fail to use the care and judgment that will insure our getting in full the benefit of all that money spent in experience that has evolved the best road specification for our purpose; we should use just about one thousand times as much as was done in the case of the wagon.

The proper selection of the road specification is, of course, very many times more complicated a matter than was that of the wagon. How it will pull, and how it will *last*, are still our main considerations; but in this case proper location, proper grades, proper drainage, proper surfacing materials, and a proper combination of the materials, all form an exceedingly complex and inter-related problem, a balanced solution of which is necessary in order to insure that we shall get the complete specification which will secure the largest public benefit for the money spent. In every one of these details, dearly-bought experience of others has made it possible for us to avoid, if we are sufficiently careful to learn and profit by past experience, the mistakes that have been made before us. We certainly do not want to spend the public money in doubtful experiments in roads, any more than we would in our wagon building in the local blacksmith shop, as long as there is this great fund of experimental knowledge already at our command.

Already, I hope, I have made clear enough to you the prime importance of getting the best and most complete specification for our road, whether we build it ourselves or let it out to be built by a contractor; the specification does not at all depend for its usefulness on a contract attached to it; it is absolutely necessary to us whether we make a contract or not. We are ready, then, to discuss means of securing the best specification for the road we are to build.

In the case of the wagon, we delivered ourselves entirely into the hands of the man or corporation who we knew built the best wagons, after we had supplied the judgment that determined the class of wagon that would be cheapest for us in the long run. In that relatively simple case we knew that honest *construction* was sold with the best specification; the established business success and continuance were involved in his keeping up his standard of excellence.

We are after the same thing, essentially, in our road building. No fair man would claim that it was impossible to find a road contractor experienced enough and honest enough to deserve our confidence in delivering ourselves entirely into his hands, to locate our road, grade it, and complete it; doubtless there are cases where this proceeding would result honestly and satisfactorily. But as long as human nature is what it is, there are few of us who would like to risk many hundred thousand dollars and the confidence our community has placed in us, on a business arrangement which places a man at both ends of a contract in that way. What we must have, to be faithful to our responsibilities, is a man who has absolutely no interests at heart in carrying out our affairs, except *our* interests. What we must have in order to be sure that we are getting the proper complete specification, is a *practical* man in the business, who is absolutely *our* man.

You probably thought I would say "a road engineer," didn't you? I do not say that; you certainly do not want a man whose only qualification is that he knows how to run land lines with engineering instruments, and calls himself a civil engineer. Neither would you be entirely safe in his hands on the basis of his further claim to have studied all the books and bulletins published on road construction. There are thousands of good, honest men who know more than they can understand.

What we must have, in order to plan in detail beforehand—that is, to draw specifications—for important road work, is a practical man who is not only experienced himself in that kind of work, but who has studied just as widely as possible the experience and the mistakes of others, and digested the results of his study so that he can apply it. Equally, of course, your man must be incorruptibly honest. It seems evident, then, that to secure our necessary share of the definite knowledge that experience has made available for us in all parts of the world, we have got to look for a certain amount of education in our man. And when we find him, who seems to combine the qualities we demand, I am frank to tell you that I believe we will find him calling himself an engineer of some kind.

If my reasoning has been convincing to you thus far, you are now ready to ask me where to find such a man and how to be sure of him when you see him. Certainly you have no inclination to give yourselves completely into the hands of any man who comes up, makes a good appearance, and says, "Gentlemen, here is my school certificate as a highway engineer; I am therefore the custodian of the wisdom of the ages in all matters appertaining to planning and building roads." I confess to you with shame that I am not sure. It seems to me, however, that in lack of any clearly established standards for such men to meet before the law of the State, that the most practical move to make is to consult very-fully with the State Highway Department, and endeavor to secure its approval of the qualifications of the man who is to decide questions on the proper solution of which will depend so many thousands of dollars of profit or loss in such a matter as the spending of the average road-bond issue is likely to be.

And now I am afraid that I have worn you out with specifications, and still there is the subject of the contract to be touched on; and in connection with that I shall run over the headings that proper specifications should always cover. But it seems to me that the supreme importance of devoting the utmost care to the preparation of the plans and specifications in advance of going into the work, has been worthy of all this time you have let me give to it.

THURSDAY MORNING, FEBRUARY 25.

MR. PRATT.—The subject for discussion today is perhaps one of the most important phases of road work and one of the hardest problems connected with road work that we now have facing us in North Carolina, i. e., THE MAINTENANCE OF PUBLIC ROADS. I want to say a few words in opening this discussion, and then call on each county represented and hear from it as to whether there has been any method worked out or attempted to be worked out in regard to the maintenance of its public roads; and, if so, has the engineer had the hearty coöperation of the local commissions in trying to put into practice the method which he believes would be a satisfactory method of maintenance of roads. There is no question whatever but that in North Carolina today we can obtain without very much trouble the money necessary with which to construct roads. It is not very hard now to go into a county, and by a campaign of education get that county to vote bonds for good roads, provided you can assure the people of the county that in the bill providing for the bond issue you have certain restrictions in connection with the expenditure of the bond money that will insure that the bond money will be spent under the supervision of competent men. The hardest problem confronting us today is the question of the maintenance of roads; and it has been found extremely difficult to have included in the bill authorizing the bond issues a definite clause in regard to the maintenance of the roads after built. Undoubtedly, one of the factors, or one of the causes or reasons, that has worked against the good road work of North Carolina has been the fact that so many counties have built roads and then let them go to pieces. We must realize that the minute a road is constructed we must begin to maintain it; I think a good illustration of the truth of this statement is the \$11,500 per mile road built in Wake County. It is a section of the road leading from Raleigh to the Country Club. It was supposed to have been put down in as nearly as perfect condition as the people could obtain. It is a concrete road with a thin surface of bituminous material and screenings on top of that. That road was not maintained, with the result that on one side of it a section of the surface approximately fifteen to twenty feet long and three to four feet in width has broken off and dropped down about one inch or more below the balance of the road. The bituminous material has peeled up in spots and the surface is pitted in a similar manner as smallpox marks the face. The concrete has cracked in several places. The point I wish to bring out is that there was no provision whatever made by the county to take care of that road. Since it was put down I do not believe the county itself has done anything to maintain it as it should in first-class condition. As I stated before that mile of road cost \$11,500, and you would expect to have obtained a road that might have gone a year without any maintenance charges, but it did not even go six months. This emphasizes the point that all roads need constant maintenance.

When we come to the other forms of surfacing materials such as bituminous, macadam, gravel, and sand-clay, the question of maintenance is more acute; and it is absolutely necessary that maintenance should begin as soon as the road is completed. We were talking yesterday in regard to thoroughness in our work; but no matter how carefully the grading of a road may have been or how careful and thoroughly the surfacing material may have been put on, there is always a chance that a weak place may develop in the surfacing material. This very often begins to show itself by a slight depression, but if we have a method of maintenance in force, these depressions will be repaired as soon as noted. If you will notice when the maintenance work is done in many counties, you will find that apparently the county authorities have decided that only during a certain season in the year will they do any repair work or maintenance on the roads. Very often that particular time of the year is not the time of the year when roads should be repaired. As brought out yesterday in regard to surfacing, do not begin to repair your dirt or sand-clay roads just as winter is coming on when they do not have a chance to become thoroughly packed and solidified before the winter rains and freezes begin. I have seen a great deal of maintenance work done in North Carolina just at that season of the year. Do repair work in the spring and summer; but do maintenance all the year. In planning your method of maintenance, do not pick out any one season of the year as the only season when maintenance is to be done. Maintenance should be continuously done all the year. If necessary, it should be done every month, every week every day. Maintenance should be done when the roads need it, for, if you do not, the maintenance charges are going to constantly increase, and finally you will have a repair bill that will be many times in excess of an annual maintenance charge.

With the sand-clay, gravel and topsoil roads, if such roads have been thoroughly graded, and the surfacing material has been put down thoroughly and carefully, there should be no trouble in maintaining these roads in first-class condition throughout the year at a cost of \$50 per mile per year. This, however, cannot be done if you drag the road only once or twice a year. You must drag the road after every heavy rain. These rains may soften the surface one-quarter to one-half inch deep, but if the road is dragged right after the rains, these incipient ruts will be ironed out smooth and hard. I believe the reasons why some of the counties have been able to have good roads during this past winter will be brought out in the discussions this morning.

With the water-bound macadam road the question of maintenance is a great deal harder problem and more expensive than it is with sand-clay or topsoil roads. As stated, I believe it is possible to maintain a sand-clay or gravel road in good condition for approximately fifty dollars per mile per year; and every county should provide fifty dollars per mile per year for the maintenance of these roads. With the water-bound macadam the cost of maintenance will be very much higher. I believe the smallest amount we can get along with is \$125 per mile per year in maintaining a limestone macadam. Macadam roads made of diabase rocks, or trap rock, will cost from \$150 to \$175 per mile per year for their maintenance. If soft porphyritic or gneissic rocks are used in making the macadam road it will require from \$200 to \$275 per mile per year to keep such a road in good condition. While limestone is a particularly soft rock (composed of particles of the mineral calcite) yet on account of the ease with which the particles of road will cement together, the cost of maintenance is reduced. Where diabase rocks are used which have greater

cementing value than ordinary white granites and gneisses, the cost of maintenance of roads built of the former rock are much less than those built of the latter. Now, if you do not maintain a water-bound macadam road constantly year by year, but instead let it go for several years, you will find, when you do come to repair it, that the cost will be something like twice what it would have been if you had maintained it year by year. We have plenty of illustrations of this in all the counties of the State, as Durham, Guilford, Mecklenburg, Buncombe, and, in fact in every county where the macadam roads have been built. The old idea regarding macadam roads was "that when once built they would remain first-class roads without any repair work being necessary." About two years ago the road leading out from Asheville towards Fairview, which had been down seven years, was in very bad condition. The commissioners were obliged to remake that road at a cost of approximately \$1,900 to \$2,000 per mile, nearly twice what it would have cost if they had maintained it year by year. Take for instance the road between Chapel Hill and Durham, to bring that back as a first-class water-bound macadam will cost at least \$2,000 per mile, and it has not been done ten years.

Now another thing in connection with maintenance which we should keep in mind is that as you maintain your road regularly and constantly, you are decreasing your cost of transportation for those who use the road. Take a macadam road that is wearing out, and the cost of hauling over that is very much increased as compared with the hauling over a smooth macadam road. The cost to automobiles going over such roads is high, some automobilists claiming that it costs per year in tires alone more than enough to put the whole road in first-class condition. We all know that loose rock is very hard on automobile tires. In making the trip from Atlanta in connection with the *New York Herald-Atlanta Journal* tour, we traveled the valley pike from Winchester to Staunton, Va. The party paid something like \$340 toll for the privilege of riding over the road; but it was estimated that the tires were damaged to a greater amount. The method of repairing the road at that time was simply to crush the rock, which was placed on the roads and left for the teams to crush and pack. The first repair work on this Durham pike was very much the same—the loose rock put on with a little clay to hold it and then left for the teams to crush, grind down and bring into shape.

When it comes to building improved roads, I do not believe it is a feasible or practical proposition to build more miles of improved roads—surfaced road—than you have provided a maintenance fund with which to take care of such roads after they are built. There should be a definite relation between your construction and your maintenance fund. We should never draw on our maintenance fund for construction work. That is being done and has been done in a great many counties. Alamance County issued bonds, but the bill that authorized the bond issue only permitted the commissioners to tax the people of Alamance County for a sum sufficient to pay the interest on the bonds—not one cent allowed for maintenance of the roads constructed. It was not long before they realized they must have some fund with which to maintain the roads, and they borrowed it. That was one of the first cases where county or road commissioners, going on the principle and the decision of the Supreme Court that public roads are public necessities, borrowed the money to maintain their roads. We must not as engineers let our enthusiasm

for construction work get ahead of the practical side of the question of maintenance. We must keep a definite relation between our construction and our maintenance fund. Now if this is taken up at the time a county is discussing the question of issuing bonds and you go before the people, and insist that a clause be inserted in the bill—an amount shall be raised sufficient to maintain the roads—and you explain to the people exactly what that means, you will find that there will be less people against the bill and more for it for the fact that the law provides a maintenance fund with which to take care of the roads.

About five years ago we had a bad winter on roads. We had the cry go up that sand-clay roads were going to pieces. At that time we tried to get information regarding the road, how it was built, its condition before the bad weather and why it went to pieces. We found that a great many of those roads had surfaces of sand-clay or gravel anywhere from four to six inches thick; but the water seeped under and got the clay underneath the sand-clay surface soft and the traffic simply crushed in the surface. You need not expect four, five or six inches of even good sand-clay surface to stand up with nothing under it. It is absolutely essential to the maintenance of roads to be sure that the drainage system is maintained. It would not be very economical or practical in working out a drainage system of roads to put in your culverts two to four times bigger than there is any need of their being, because you expect them to stop up. It is the business of the foreman or superintendent in charge of maintenance to see that they are kept open.

I believe we should put into effect in the various counties in North Carolina a practical system of maintenance so that the roads can be maintained in good condition throughout the year. What is a good practical system of maintenance? What methods have proved satisfactory? I hope in the responses by the engineers and superintendents from the various counties that we can find out what they have been doing or trying to do and in that way we can get information we can use in our own county.

There is one thing that has worked against the method of maintenance; that is, politics. That probably has done more to keep roads from being maintained in winter than any one thing, and it is politics that is taking the maintenance fund and using it for construction work. The idea has been to have built as many miles of road as possible. Many commissioners want to say they have built so many miles of road and the tendency is to take the maintenance fund and use it for construction work and thus be constructing more roads than there are funds with which to maintain them.

A dirt road if built right, with surface free from stumps, can be maintained, I believe, in pretty good condition for travel at a cost of probably one-half what it will take to keep the sand-clay or gravel road in good condition.

I am going to call on the men whose names are on the program and ask them to take up this question of maintenance, and give us their ideas as to what they think would be a good plan to carry out.

Road Maintenance

By W. W. Crosby, Consulting Engineer.

The importance of the subject of maintenance can hardly be overestimated. I am reminded in a way of a story that I heard the other day about a darkey who had had some funds in a bank. He had been saving a little from time to time, when suddenly the bank failed. The darkey said he had "been hearing

about those things all his life," but he had "never had one to bust right in his face before." Now, the importance of this subject of maintenance has been recognized abroad for a good many years. We hear a great deal about the excellence of foreign roads and we wonder, perhaps, at the explanation of their superiority. I have had the good fortune to be able to make several trips over there to look into road matters and on each occasion have been accompanied by other American engineers. We examined the roads very carefully. We dug into them and asked all sorts of questions, as each one of us had in mind the remarks we had had made to us from time to time by people interested in roads in this country something of this nature: why don't American engineers build as good roads as they have in foreign countries? We felt perhaps a little tender on the subject. We thought we could build as good roads; so, as I say, we went there with the idea of trying to inform ourselves as to why they were better over there. The result of our investigations was the unanimous opinion among all the engineers who went into the subject—and they went into it for the purpose of informing themselves as to the merits of these roads—that the superiority of the foreign roads was simply and solely due to the better maintenance accorded the roads in foreign countries, and I think there is no question but that the apparent superiority of the roads, which you hear frequently referred to by people who go abroad and then come back here and travel over American roads, or by people from abroad who come here and condemn our roads, is due to the better maintenance accorded European roads.

There is another viewpoint, and that is one that should appeal to every American citizen because Americans are especially keen on financial matters. That point is this: that it is absolutely useless, if it is not actually criminal, to put public money into expensive construction and then to let it go to pieces. That sort of thing is not done by the individual. There is not a man who would build a house and put care and money into its construction and then expect that house to keep itself in good condition. You would expect, from the start, to annually average a certain sum of money for the maintenance of that house and you would not start out to make any outlay for construction unless you were sure that in some way you were going to provide the necessary funds for keeping the completed work in good condition and that you were going to see that these funds were properly expended. That has not been the case with the expenditure for public roads until comparatively recently. It has not been the case probably for one or two very apparent but never good reasons. One reason the desirable condition of affairs has not existed is this: there have been so many demands on the road authorities for the improvement of absolutely unimproved roads that they have had no funds, no time, no thought left to give to the maintenance of those roads which have been fairly well improved. Once they made an improvement from available funds, their attention to doing a similar thing was attracted somewhere else and they were obliged by force of circumstances to let those recently improved take care of themselves, at least to a large extent, and to concentrate their time and thought in putting in similar work on other unimproved roads. This is especially true, of course, where the funds are extremely limited and it might be said that a sort of habit has grown up which prevailed even after more liberal funds were provided. This condition of affairs prevailed in my own State of Maryland when the State Aid Fund was first passed and we had ample funds to meet the requests which first reached us for

improved roads according to modern methods. The improvements were made and they were apparently so satisfactory that other localities would demand similar improvements and the old habit of neglecting the earlier improvements, at least temporarily, prevailed during the earlier years to a greater extent than it should have. Later, as the necessity for repairs could not be resisted and the roads could not be neglected any longer, the repairs were made, but the bills were so great as to shock the authorities into considering the question. They soon saw a different form of procedure on some of the newer pieces of road would be much more economical, and that it would be much more satisfactory to accord the new improvements continuous maintenance from the proper viewpoint. The railroads of the country, as far as their physical work goes, are pretty efficient. It is only when matters of high finance creep in that the efficiency, perhaps, as regards results returned for money invested or acquired for investment is questionable. In doing the work, any of you who have had business with the railroads know that they require a fair amount of work for the money paid you for services. How do the railroads maintain their properties? They do not go around once a year. They do not send a gang periodically to repair tracks, but they keep at them every day, and it is only by some similar system that the public roads of the country can be efficiently and properly maintained. It is absolutely useless as I said, and I believe it is in many cases criminal, to borrow money and to build a system of improved roads, with all the expense, with all the thought, time and money required for satisfactory results, unless some proper arrangement for taking care of the completed roads is made from the start. On an average it probably requires about five per cent, more or less, according to local conditions, of the cost of the road annually for its maintenance. It will run between three and ten per cent, according to traffic and the character of the construction, efficiency of construction, etc. I mention this point because I know a great many of you will be consulted and a great many of you will use your influence with the lawmaking authorities in favor of better roads even though you may, perhaps, have nothing to do with the actual expenditure of the money afterwards. On the other hand, some of you will be connected with the movement from the propaganda clear through to the maintenance end of the work, and you must use your efforts from the beginning to see that proper provisions are made, both financially and otherwise, for the maintenance of the results after the work shall have been completed. The borrowed funds of the community can be regarded as its capital and the receipts from the taxes as its income. The capital, the borrowed money, should not be spent in any case to pay annual expenses. The capital should be reserved for investment as far as practicable. That is, capital or borrowed funds should be put into the permanent features of the construction just as far as it is possible to make them go and as a general principle the annual expenditures should be made from the income of the community, that is, from the annual receipts of the tax levy.

Occasionally I have seen communities where borrowed money was used for both construction and maintenance. I think it is the rankest kind of finance to use borrowed money for any purpose except permanent improvements. A continuance of that sort of thing would lead to bankruptcy.

To a considerable extent the details of construction work have been allowed to interfere with the proper maintenance of roads. Construction work is more interesting and has more or less of the spectacular in it. Maintenance work

is drudgery, compared with construction work. Maintenance work is the constant, steady performance of little things, the unremitting attention to details, and after a while it gets very monotonous. On the other hand, any form of construction appeals to the average man from childhood up. It is a very natural thing for the problems of construction to attract more attention than the problems of maintenance; consequently, in an organization where the men in it have both construction and maintenance to look after, the tendency is to have the maintenance neglected and have the bulk of attention given to construction features. That is one reason in some cases, at least, why maintenance has been neglected.

As a matter of fact, most of the construction problems really proceed from the basis of maintenance problems. For instance, in figuring on the size of a culvert, probably the controlling factor in determining that size is the factor of the proper and economical maintenance of that culvert. If made too small, it cannot be maintained. It will be washed out. In designing or selecting the character of surfacing for a road, one kind is selected from the others because, under the traffic and local conditions, it will be more cheaply and satisfactorily maintained. You see, the maintenance idea comes right in at the beginning when you are planning for the construction itself. Of course, the first cost comes in also, but the point I want to make is that the maintenance problem really begins before the construction has commenced and not after the construction is finished.

The first problems of maintenance are probably on any kind of a road the proper maintenance of the waterways and the drainage structures, because unless these are properly maintained it will be impossible to maintain the surfacing or other features of the highway. Frequently, however, little acts promptly and properly performed will prevent serious damage. For instance, if a ditch becomes clogged during a storm by a branch or bush falling down into it and somebody comes along shortly after and removes that obstruction, a serious washout in the roadway may be avoided. That is especially true where the roadway is unpaved or surfaced only with a fairly weak road-crust and where there are considerable banks of earth exposed on the other side. A little stream of water may get started in the wrong direction across a road or along a shoulder of the road, and if some one happens to correct it while small, a serious bill for repairs may be prevented. It is very important that the waterways be kept open and the drainage unobstructed. I remember this subject was being discussed, I think, in Chicago, and Mr. Cooley, State Highway Commissioner of Minnesota, was there. In some parts of Minnesota there are long stretches of flat country and the need of under-drains is very frequent. They use three or four-inch pipe in carrying the water in underground drains. Similar conditions occur down on the eastern shore of Maryland and a county road engineer was present from Maryland. After Mr. Cooley had finished speaking, the Maryland man put this question to Mr. Cooley: "Down our way we have great difficulty in keeping the muskrats out of the under-drains. They get in and stop up the drains. I would like to ask Mr. Cooley if he can suggest any remedy for that condition of affairs." Mr. Cooley said they had had a similar condition in Minnesota, and had found that by putting hollow logs alongside the tile of the under-drain, which was exposed at the entrance, the muskrat would enter the hollow log rather than the under-drain and leave the drain alone. Now that illustrates, perhaps, the ingenuity required of a good man on the maintenance end of the work. In

many cases he can save great expense by very simple expedients. It was probably a very cheap way of avoiding the muskrat. Incidentally, I suppose, they made money out of the muskrat skins and helped pay expenses. Persistence, ingenuity and ability to overcome difficulties in an economical sort of way are what is required of a maintenance man.

Incidental to the question of drainage comes the question of keeping the water out of the roadway itself. Earth roads should be shaped up like a roof to shed water and unless the earth road is kept in this condition, water accumulating on it will soak into the roadbed and very quickly make the road difficult to travel over. About the only thing that can be done to an earth road short of surfacing it is to keep the surface of the road in as good condition to shed water as possible. That, of course, is most effectively done by the log drag. If an earth road is kept in proper condition to shed water—that is, kept crowned up and smooth, and that work done frequently enough—it is possible under average conditions to keep the roadway from becoming saturated with water to an extent that will be seriously objectionable. The surface may become slightly muddy, but the proper and persistent use of the road drag, together with constant vigilance, such as, for instance, the filling of a hole where a slump may occur for one reason or another, will keep the earth road in a very satisfactory condition.

With a sand-clay road there is a slight roof in the shape of a sand-clay mixture placed over the earth foundation and so much help has been given the maintenance authorities toward the protection of the road, but it is still necessary to maintain that roof, and I might say here it is necessary to keep any roof as impervious to water as possible if good results are to be expected. It is the water getting in one way or another that does the damage in ninety-nine cases out of one hundred. The log drag is the instrument for use in the maintenance of a sand-clay road.

A sand-clay road cannot be built in what might be called one period. That is, you cannot go in and build a satisfactory sand-clay road in a short period of time and expect it to be and stay entirely satisfactory. The most successful results are obtained by constant attention to the sand-clay surfacing for a period extending over several years, so as to bring in opposite kinds of seasons during the construction and bring them in more than once. The mixing of the sand and clay is probably best done in most cases by the hoofs of horses and the wheels of vehicles, and it takes time for that to be accomplished fully. You can aid them to some extent by mixing when the road is under construction, but after a road has settled down the maintenance for a few years may be regarded as part of the construction. Effective mixing of the sand and clay is desirable and it is only under traffic or maintenance that the defects will be clearly brought out. In wet weather, muddy spots may develop under traffic. That shows the need of more sand. In dry weather loose spots may develop, which show the need of additional clay to these places. The final mixture, with the proper balances between the sand and the clay can best be had by proper maintenance over a long period. You must keep the surface of the sand-clay road as smooth as possible to shed water. In adding sand or clay it is desirable to add sand in the fall of the year and clay in the spring of the year, as far as a general rule of the kind can be applicable to the needs as they crop out. Keep in mind if the road is inclined to be a little bit muddy in the spring, that it will be better to delay putting any sand on the road until fall and vice versa. The excellence of the results will justify a little inconvenience in the meantime.

Gravel roadways may be said to be the next step toward a highway with a more enduring surfacing over the sub-grade, and the drag is again useful with gravel roadways. However, as the roof or roadway becomes harder and firmer as we progress toward the pavements, the drag alone loses some of its effect and its use may have to be supplemented by picks or steel tools of a like character. The shod drag, that is, a drag with a piece of wagon tire along the edge of the log, will of course be more effective on hard surfacing than the unshod drag. With a gravel road, the maintenance procedure has to be between the procedure in the case of a sand-clay and that of a macadam.

Properly constructed water-bound macadam will show, perhaps, two tendencies. One great tendency is for it to ravel. This may occur in dry weather on any road, and it is especially noticeable where there is much automobile traffic. The automobile sweeps the fine material forming the binder, and protecting the road against the loosening of the stones to some extent, from the surface, and the stones begin to ravel. As soon as stones get loose, the road begins to lose its impervious character, and begins to be susceptible to penetration by water, which is what you do not want. One way to prevent the ravelling of macadam, and a very effective way where there is too much automobile travel, is to simply cover the road lightly from time to time as may be necessary with sand. A very thin coating, perhaps one-eighth to one-fourth of an inch, will give astonishing results in helping to protect the macadam and to prevent it from ravelling. If, however, the objection to dust is too great, or if the automobile traffic is too heavy for a simple expedient like the one mentioned, generally the only thing that can be done is to apply some form of bituminous material, ordinarily known as "oil," to the top of the road. If the "oil" is of an asphaltic character and contains a fair amount of what is ordinarily known as "asphalt," the application of the oil to the macadam does two things: It penetrates between the stones somewhat, in many cases helping bind the stone together; also it helps make the road-crust impervious to water and, with the fine material on the surface of the macadam, forms a carpet which itself will take the wear instead of allowing the wear on the macadam.

That brings us to the bituminous surface, which is now generally known to be a thin layer of bituminous material incorporated with fine mineral material, such as stone, dust or sand, generally mixed under the traffic, and forming a sort of "carpet" or "mat" or "blanket" over the macadam stones themselves, like a linoleum or oilcloth on the wooden floor. Just so long as that carpet is kept in good condition, there is little, if any, wear on the macadam underneath, and the whole problem with the bituminous carpet becomes that of keeping it in good condition in all places. Certain bituminous materials form quite lasting carpets when mixed with sand or stone. Others last for a little while and then the carpet disintegrates, so that it is desirable to select bituminous materials, as far as you can, which will remain coherent as long as possible under the local conditions.

The next problem with bituminous carpets is that of keeping the carpet in place, as a very common tendency of bituminous carpets is to peel off under certain conditions. They sometimes peel off in wet weather in spots of a size varying from that of the palm of one's hand to that of the top of a table. Again they sometimes peel off without apparent cause. If a hole does form in the carpet and the repair of that hole is neglected, it is astonishing with what rapidity the wear will take place. Wear seems to take place then in the

macadam beneath a great deal faster than it would if there were no carpet on the road. The remedy is to repair the small places as fast as they appear and it is most important that this should be done for the sake of satisfaction and economy

I have spoken a good deal about the necessity for promptness in making repairs. Two systems of maintenance have been more or less distinguished from each other, and arguments are made by different parties for one or the other. One system is known familiarly as the "patrol" system, and the other as the "gang" system. It is, of course, entirely possible that the local conditions of any case will demand the selection of one system instead of the other, but from my experience I believe that ordinarily the "patrol" system gives very much better results than the "gang" system. In any event, I think that the patrol system is at the bottom of, or underlies the gang system. I have already instanced the system of the maintenance of the railways. They may have "repair gangs" but under and behind their "gangs" are "patrols" in the form of track-walkers or individuals from the section-gang that are attending to such work. In the same way, in the repair of county highways and of State roads, and for reasons already mentioned, such as promptness, I think we cannot get away from the patrolman. If the patrolman's work is properly done, there is far less necessity for gang repairs and they will be needed with much less frequency than if the patrolman is not kept and if the little things have not been prevented from getting to be big things. In any "gang" system the visits of the gangs must be intermittent. They cannot be made every day. Between the visits of the gang there will be a number of little things which should and can be attended to by a patrolman, and if attended to, will avoid the necessity of a visit from the gang. It is true that in the course of time, even under the patrol system, the amount of work to be done necessary to put the road in good condition again will quite likely require more than the labor of the patrolman, the doing of which will prevent the necessity for larger things. I have never seen a case where the work of the patrolman would not have been a good thing to have had. I have seen a great many cases where if a patrolman had been employed and he had been anything like efficient, the expenses of maintenance would have been greatly reduced and the necessity for gang repairs would have been avoided to a large degree.

There is one set of conditions under which a gang system of repair may have more to support it than any other, and that is where convicts are worked on the road. It is not always practical to work convicts as patrolmen. That has been done successfully, however, in some cases. Ordinarily they are worked in gangs and in those cases the arguments for the gang methods are considerably stronger than they are where free labor is employed.

The problems of construction will probably continue to be presented for a considerable period yet. We have a great many miles of road yet to build even in the states where millions have been expended for road construction in the last ten years, but on the maintenance problems we are already behind. We have to catch up. These maintenance problems certainly will increase, not only as often as construction problems do but also even faster because of the changing conditions of traffic and because of the development of new materials, new machinery and other things affecting their solution. I am quite sure that such a progressive body as this will be able to appreciate the importance of attention to maintenance as well as to construction problems and that you will solve your own problems probably better than an out-

sider could tell you how to do them, but if the experience of an outsider, such as I may call myself for the moment, is of any value, I am only glad to give it to you.

DISCUSSION.

Question: How about the road from Durham here? What would you do with the old worn-out macadam?

MR. CROSBY.—I did not come over that road, but I may say we have had that problem in Maryland to a considerable extent. We have a good many miles of turnpike there and in a way they may be called "old worn-out macadam." We resurfaced some of these very successfully and at a fairly reasonable cost by simply loosening up lightly the old surface with a scarifier, adding the new crushed stone necessary for the proper shape and surface and rebinding the macadam. In some cases the old stone was sufficiently thick to stand loosening up to a greater extent. In such cases we loosened up to a depth of six or eight inches, and in doing so we brought to the surface large stone, together with a lot of finer material. The large material we broke up with hammers; then we harrowed the loose stone so as to shake the fine material down below the surface; then we shaped the roadway and rolled the stone down, binding it with the aid of sand or stone chips and water. Thus we produced a very fair macadam. In some cases, however, we had to abandon the old roadway altogether because the location and grades were not right.

Question: Are you an advocate of mixing sand-clay roads both by dry and wet processes?

MR. CROSBY.—I should do it with both methods as well as I could. I put more confidence and faith in the final mixing by traffic, and subsequent maintenance with the harrow and drag.

Question: What type of harrow do you use in mixing?

MR. CROSBY.—Ordinarily a spike-tooth harrow, which is a little easier to draw around and works better with light teams. I do not, however, know that it has any particular advantage.

Question: Does it give any more thorough mixing than the disk?

MR. CROSBY.—I think to a certain extent it would, in that it is a finer tool than the other. The disk harrow, I think, is more likely to leave lumps of clay with sand around it than the spike harrow does. I think the spike harrow very likely can be depended upon to break up clay better than the disk harrow.

MR. HUGHES.—I do not claim to know much about the proposition, but I agree with you on the proposition that both should be used and then some on that proposition of harrowing. I had one last year that I considered the best one I ever ran up against, a 24 disk harrow, 12 on the front and 12 on the rear, the first cutting out and the rear cutting in. On first sight it looked like a pretty expensive proposition to run it because it takes four good, stout mules to pull it, but it covers so much space you rarely have to run it long. I think it has a base of seventy feet, and is one of the most complete mixing machines I ever saw. In addition to that I always use a spike-tooth harrow and then some. If two harrows can be used, you get much better results. As to a choice between the two, I would recommend the disk harrow, followed by the spike-tooth, but if you cannot get but one, I would take the spike-tooth.

Question: Have you had any experience with glutrin on sand-clay roads?

MR. CROSBY.—I have used glutrin in a number of forms. In some cases it

has not been economical, although it has done exactly what we wanted it to do. As regards sand-clay or gravel roads, glutrin will considerably add to the binding qualities of certain kinds of clay which may be found available for sand-clay roads or may be present in gravel.

Ordinarily these clays either in the gravel or by themselves would not give satisfactory binding results, but if they are used with the gravel or with the clay, to make the mixture, with the addition of glutrin, they will give entirely satisfactory results. It seems to have an action on the clay which increases its elasticity; and in the following spring when wet weather conditions first begin, a rather sticky condition of the surface will have to be looked out for, because it puts the road in a tender condition. It is very likely to be damaged by traffic. The remedy, of course, is to spread some sand over it, but if your maintenance organization is not sufficient to take care of that tender condition of the road, there may be some danger of using glutrin too late in the year. If used early in the year, that condition will not appear in most cases.

Question: What do you think of bituminous materials for sand-clay roads?

MR. CROSBY.—I have had no experience with them. I do not see why they should not be used under some conditions. Under other conditions I should hesitate to use them. I might explain by showing that bituminous material and sand will mix together and form a carpet very satisfactorily, but bituminous materials and clay or finely divided material similar to clay form a combination which in wet weather is likely to turn into a disagreeable, black, greasy mud. Now it will depend on the sandiness or clayeyness of the road as well as upon the character of the bituminous material as to whether the use of the bituminous material and sand-clay mixture can or cannot be properly made.

Question: Do you think where you have a concrete base something like sheet asphalt, that it pays to put concrete back, using cement, or clean rock and then put bitumen back?

MR. CROSBY.—If I had a concrete base in the first place, and it was broken all the way through, I should put concrete back every time, as it will hold better.

There is one important thing to remember in connection with road construction, and that is, providing for a system of maintenance. I did not bring it out because it applies to the construction end. That is, the greater uniformity you can secure in the road course, the better road you have. Now if you can get an absolutely uniform surface, both as to thickness and proportion and size, quality and fineness of surface, the greater the uniformity of wear that will be had on that surface, and the greater the uniformity of wear, it is evident, the less need of repair to the road. If there happens to be a little soft spot in a macadam road, that will wear out and you will have a bad place formed; whereas if it is uniformly surfaced, the whole thing would wear down uniformly and you would have no repairs theoretically until you have worn the whole surface thin. In my judgment, I should very much prefer to have that concrete base restored so as to get uniformity back again into the surface.

THURSDAY AFTERNOON.

Bridges and Culverts

DR. PRATT: Mr. Fleming, of the Newport Culvert Company, will open the discussion this afternoon in connection with culverts. There

are four types of culvert—terra cotta, concrete, cast iron, and corrugated metal culverts. I do not believe any of us is in a position at the present to say what one type of culvert can replace all others all the time. There may be a place for each and the use of any certain kind will very often depend on location and road conditions under which the culvert is to be used.

GENERAL DISCUSSION.

MR. FLEMING.—I feel rather out of place here talking about culverts, because I am not a practical road or culvert man. I know that a culvert is a ring with a hole in it that you stick under the ground and let the water run through, and that lets me out. But I am here to discuss the quality of metal that enters into the construction of metal culverts. Now there seems to be some misapprehension on the part of a few road builders that a metal culvert is a sort of a transient thing and that in the course of a few years it rusts out and you will have to replace it.

In the first place, we have our idea of sheet metal rusting; we have conceived it entirely through experiments with thin sheets. Up to about ten or fifteen years ago, road people were raising such a howl about the rusting of steel that the steel companies began to all wake up and try to find out what was wrong with the steel; so, since that time we have had several big concerns greatly improve the quality of the material entering into their sheets. Now, I might say, the condemning of steel has come about particularly through the employment of very light sheets. The consumer, as you all know, wants something cheap. He orders the lightest kind of a sheet, and expects it to last a lifetime. He orders a 28 gauge sheet and the manufacturer has perhaps given him a 30-gauge; in other words, he has swindled him. Now a 30-gauge sheet is entirely too thin, and it is no wonder that any kind of material would fail without any more body than that.

When we come to the subject of metal culverts, we are still handling sheet iron, but sheet iron with body to it. For instance, 16-gauge sheet which I think is the kind usually put into culverts, is 1-32 of an inch thick. Now there is considerable body to that sheet. When a heavy gauged metal begins to rust, some people might think it is only a question of a very short time till it is going to rust through. I have had one occasion here not very long ago to notice that in connection with culverts. One of our customers or somebody returned to our plant a piece of steel culvert about six inches square that had rust spots on it; the spelter was gone and that person claimed that that material had begun to decay and that it was absolutely useless. Now he was borrowing trouble before it arrived. He simply did not know the condition or what was going to take place in that culvert in the future. It was a 12-gauge culvert with lots of body to it. I cleaned it out thoroughly and it measured .001 of an inch. Now that culvert, I know, would not have eaten through there in a long time. There would not be a hole in more than twenty years, because the metal was so thick that when corrosion takes place it sloughs off a little, but there is still a lot of the sheet left.

The steel companies in advertising a slow rusting material have been guided by what we call the electrolytic theory of erosion. In brief, a theory that says iron rusts because it passes into solution with water that gets on it and that solution corrodes or forms an electrolyte; an electric current flows through that and causes rusting. We have worked along that basis and made

a great improvement in the quality of these sheets. We have eliminated an excess of sulphur or phosphorus or manganese from common steel which is detrimental. When these elements are eliminated we have a material that is unquestionably better than the steel which contains it; but in our clays we have found out through repeated and costly experiments that the pure iron has not gone far enough. There is a step further. For instance, if we could sell a material with 4 per cent of nickel in it to the consumers of culverts, we would make that sort of material and I believe it would outlast a 12-gauge culvert. But to come down to material that is marketable, that we can sell for a price that would justify us making it, we found that a small addition of copper retards its corrosion. Now there has been a great deal of talk about this copper proposition in metal culverts; some of the enemies of copper claiming that it is an impurity.

Now, gentlemen, copper, if it is an impurity, is a costly impurity for our company. We manufacture pure iron containing no copper, and we deliberately put in a certain percentage of copper when copper is fourteen cents a pound. Now we always have and always will find this idea or scheme of trying to call something we put in there to give virtue to the material, an impurity. This is a peculiar situation. There are four or five reputable companies making good metal culverts. Yet all five of these companies (there may be six, but I consider there are only four), if you will ask each one of these companies which is the best, they will say that theirs is the best. They will cite costly and expensive tests proving their statements. Then somebody is wrong. Who is it? That is the thing.

The American Society for Testing Materials, containing over two thousand of the leading scientific men of our country, have appointed a committee of thirty men, of which I am a member, to carry on unbiased corrosion tests. We are going to put on six hundred sheets made all over the country of different brands in three different places in the country. The results of that test will tell which one of those four or five companies is telling the truth and the four or five who are lying.

I represent one of the companies who say they are carrying on corrosion tests. There is absolutely no question in my mind as to how this test is going to come out. In two-thirds of the cases the copper iron was decidedly the best and at the end of the time when one-half of the material had absolutely failed, our material contained absolutely no holes. Out of about twenty-three cases tested, or something like that, our material was the last to have holes clear through the sheet. Now, whether I am telling you the truth or not you do not know, but you can wait five or six years and find out from the reports.

Dr. Walker, the other day in New York, at a meeting of the Industrial Chemists Society, made the statement that the greatest advance made in recent years in the manufacture of steel was in finding out that the addition of a small amount of copper to the metal greatly retarded corrosion.

As far as the durability of metal culverts is concerned, I am free to say that I believe that any of our well-made culverts by reputable steel and iron concerns will give excellent service and I do not believe you have anything to fear through the short life of a metal culvert compared with other culverts. The situation is that there are a great many experiments to be tried and that there is still room for many different ideas and it is quite natural that all people should not agree on it. It is difficult to look over the experiments

that have already been tried and to get them lined up so that you can form any one opinion from them. Testing these materials is part of my business. I was interested the other day in reading where certain railroads had turned over a set of samples for experiment to the University of Illinois to be tried out impartially as to their durability. Some of the metals contained copper, some did not; and when these experiments were finished in many cases the copper showed a much greater durability. The experimenters from the college immediately wrote to the people and asked them why they had allowed this impurity to come in, and the people frankly explained that they had been to a great deal of expense to put it in to prevent rusting. A long time weather test showed that it was so. Now we have another experiment by Chapman, Chief Engineer of the Westinghouse Electric Company, of New York, who exposed two sheets of metal, one composed of pure iron and the other of ordinary steel. He clipped pieces from those sheets and placed them in sulphuric acid for a few hours. At the end of the time the pure iron sheet was practically perfect, and the steel sheet was all to pieces. After one year he was very much surprised to find the steel sheet was the better of the two. There is a great deal about metal admixtures that we do not know yet.

Question: Is it true that either pure iron or iron and copper corrodes more rapidly under the influence of dry or wet weather?

Mr. Fleming's talk brought out a point in regard to the effects of weather and the thickness of iron. There is at the present time some dispute as to how rapidly iron rust can extend into a bar or mass of iron. There is a difference of opinion. Some had an idea that after the rust once starts and the mass of iron is coated with rust, that the rusting process was going on very, very slowly by the protection of iron by the coating of rust; but as it was cleaned off, it began to go on still more rapidly.

MR. FALLIS.—Now the question has been advanced that the reason we could use this grade of iron in making culverts was that we had a particular type of iron, an open hearth iron, a nearly pure metallic iron, and that it resists corrosion better than the other forms of iron or steel. An experiment I would like to see made is that culverts made of such iron—nearly pure iron known as open hearth iron—be put in the ground and kept there without any coating at all to see the action of the chemicals contained in the ground which come in contact with the outside of the culvert and the water passing through and the action of the atmosphere on the inside of the culvert. More stress, however, is laid upon the covering of the culvert. If you take ordinary steel and coat it with spelter, the spelter is very apt to peel or blister, and when tapped it will come off. That raises the question to my mind, how can we, in regard to corrugated metallic culverts, consider the spelter as making the main value of the culvert?

MR. FLEMING.—Two factors, atmospheric conditions and conditions brought about by whatever action the earth itself might have upon the outside of the culvert, and the atmosphere on the inside.

MR. PRATT.—We have not used to any great extent the cast iron. I made the statement that, personally, I believed it would be better to use one particular kind of culvert in a particular place more advantageously. For instance, you take in the western part of the State where you are constructing a road some distance from a railroad point, and to reach this road you have to go over a very bad, rough road. I want to use a pipe of considerable diameter. Is it cheaper and better to haul the terra cotta pipe and put that in than it is

to buy the corrugated iron?. We have used the corrugated iron in certain sections of North Carolina and it reached its destination in good shape. Other engineers report that certain corrugated iron they used crushed; while others report that theirs held up under embankments and showed no tendency to break. We do know that in laying the terra cotta we must be careful about how the earth comes in contact with it. With the corrugated iron we are supposed to be able to use that practically flush with the road surface if we wish.

REPRESENTATIVE FROM POMONA TERRA COTTA COMPANY.—There is a certain percentage of terra cotta pipe that is apt to break during burning of the pipe, before it comes out to be put into the distributing rooms. A pipe which is cracked does not ring. There was never any formula for pipe. The American Society for Testing Materials last year at its meeting in Atlantic City, adopted a standard of specifications for such pipe, and some excellent work has been done by an engineer of the College of Iowa, who worked up some tables, and that today is the only correct mathematical data that we have on it.

MR. GALVIN OF THE CAROLINA METAL PRODUCTS COMPANY.—I believe there are a lot of engineers who buy pipe like we poor folks buy furniture, knowing very little about what we are purchasing. From my experience there is a vast difference in the steel and iron. As to which is right and which is wrong is another question. There ought to be some specifications drawn up by engineers which they themselves believe to be right and which the manufacturers can follow. It is wrong to invite culvert manufacturers to bid on any particular number of feet of culvert, not specifying gauges or quality of material. I would say, as a manufacturer, that you would relieve us of a wonderful lot of trouble if you could and would draw up a set of specifications that you yourselves think should be adhered to. We assure you that we will ship you the materials under the specifications that you give us. That is the only way to conduct any business; have something to follow and do not permit everybody to run along and express his opinion and argue the question out. I recommend to you engineers that you draw up a set of specifications, mentioning gauge, chemical analysis, if necessary, or aggregate of total, and then those that get in on that specification, get in on it and those that cannot, stay out.

My only advice as a manufacturer would be to get up a set of specifications, follow it and insist that those who bid on it put up a guarantee that they deliver the material under these specifications.

I might say that it is questionable as to which is the best culvert. I do not believe that any of you engineers can relate any special instance where a guaranteed metal culvert has gone to the bad unless under some strange conditions. They are sold all over the United States and they give real good service.

Terra Cotta Culverts

Digest of Remarks by BENJAMIN BROOKS, Representative of the International Clay Products Bureau.

The road culvert has never received the engineering attention which it deserves, although it is absolutely the only part of a road which can be called thoroughly permanent and which would, therefore, deserve the greatest pains to make it so. It has too often been turned over to the entire discretion of men not versed in engineering and has, therefore, suffered accordingly. While almost any county engineer's office will be full of plans of bridges, no

standard culvert designs can be found among the drawings. This is partly because to hire an engineer to design a culvert would cost more than the culvert.

To meet this difficulty it is a very easy matter to employ one engineer to design a standard culvert, indicating the general method of construction and giving detailed dimensions in terms of the diameter of the pipe, so that, no matter what the size or location of the culvert within certain wide limits, the same standard plan can be used and the same good results can be obtained as in the design and construction of large bridges.

The United States Office of Public Roads has repeatedly called attention to the futility of building culverts without head walls; and no matter what material the culvert is build of this standard design should include very adequate head walls.

The United States Office of Public Roads has also called attention to the futility of a culvert unless the ditches leading to it are kept clean and the weeds cleared from its ends, so as to allow the free passage of water. One reason for giving the head wall ample length is to insure that the earth, falling from both ends on a slope of $1\frac{1}{2}$ to 1, shall not fall far enough to clog the pipe.

This precaution against the stoppage of culverts brings up a point greatly in favor of building them of vitrified clay pipe. Measurements taken on long lines of vitrified clay drain tile in Iowa under the direction of the Iowa State College of Agriculture and Mechanic Arts, indicate that the coefficient of friction as applied to Kutter's formula is not greater than .011, while on the other hand measurements taken with great care on the corrugated metal temporary outfall sewer at El Paso indicate the coefficient of friction for corrugated surfaces is .022. Applying these different coefficients of friction to a 24-inch culvert on a one per cent grade shows that when a culvert is running about one-quarter full—in other words during the period when silt is likely to occur—the velocity of the water through the smooth-bore vitrified clay pipe culvert is about six feet per second, whereas through the corrugated pipe it is only 2.4 feet per second.

In order to illustrate my point about the standard design of culvert and to draw the attention of road engineers in that direction, I have prepared a set of drawings and tables on this plan, copies of which will gladly be forwarded to any one addressing the International Clay Products Bureau, Kansas City, Mo.; and at the same time, in order to increase the interest in this type of culvert and to call to mind the superior characteristics of vitrified clay pipe for this purpose, I have presented a few photographs showing the manufacture of the pipe—not as it was formerly made in North Carolina, but as it is now made, starting with the hardest kind of shale instead of mere surface clay, and using the most modern type of machinery.

The shale, having reached the factory by railroad, is carried by belt conveyors to what is known as the dry mills, these being horizontal circular perforated tables of metal revolving under heavy steel-shod rollers. As the material is reduced to the fineness of sand by these rollers it passes down through the perforations and is next conveyed to storage bins and sifted, that material which is rejected by the sieves being returned to the rollers to be ground again. The sifted or screened material then passes to the wet pans or wet mills and is there mixed or kneaded with water under a similar system of heavy rollers until it is of the consistency of very stiff putty. In this state

it goes to the press, which is a combination of two cylinders one above the other, each with a piston connected by a long piston rod. The upper cylinder receives steam from the boilers above the piston, the lower cylinder receives clay below the piston.

Since the upper piston is several times larger than the lower one, many times the steam pressure is exerted on the clay. This great pressure compels it to take the shape of the socket of the pipe, and when the bottom part of the clay cylinder is removed the pressure from above forces out the clay just as macaroni is forced from the press, and the parallel barrel part of the pipe is thus formed.

The drying of the pipe is not left to a matter of chance or weather, but is conducted in large rooms with slatted floors under which an extensive network of steam pipes maintains an even temperature day and night the year around. Having been dried to hardness in the course of five or six days, the pipes are then stored in stacks in circular brick kilns and fires applied to them through six or eight openings around the circumference of the kilns in such a way that the flame does not play directly on the pipes but is deflected to the domed roof of the kiln, from which the heat is reflected down evenly upon them. The increase in temperature is very gradual for the first few days and finally reaches 2,000 degrees F. At this temperature all the inflammable or perishable ingredients of the clay have been burned away, leaving only that which is indestructible. This indestructible part is reduced by vitrification or melting to the condition of maximum density, making it impervious to water or any destructive agency from without.

This "trial by fire" largely accounts for the extremely long life of vitrified clay pipe in service and enables us to show photographs of pipe made as long ago as 7,000 years by Egyptian engineers. As a finishing touch to the pipe, salt is thrown into the fires when the vitrification has reached the proper point, and this salt combines with the clay in such a way as to cover the outer surface of the pipes with a thin layer of glass. It remains then but to allow the pipes to cool gradually and to crate them up securely in cars for shipment.

The following copies of specifications for corrugated metal pipe and proposed bid for corrugated galvanized culverts were distributed to the institute:

United States Government Specifications for Corrugated Metal Pipe

Corrugated metal pipe shall be made from metal of not less than sixteen (16) United States Standard Gauge for pipe having a diameter of 20 inches or less and not less than fourteen (14) United States Standard Gauge for pipe between 20 inches and 36 inches in diameter.

The metal shall carry not less than two ounces of prime spelter per square foot, uniformly distributed. The coating shall be of such nature that it will not peel off, and any bare or uncoated spots shall constitute a sufficient cause for rejection.

The joints shall fit evenly and close, and the jointed pipe shall be straight, circular in section, true and rigid.

All rivets used in the fabrication of the culvert pipe shall be of the same quality of metal as the pipe, thoroughly galvanized, and shall be not less than one-fourth inch in diameter for sixteen (16) gauge pipe, nor less than three-eighths inch in diameter for fourteen (14) gauge pipe.

Longitudinal joints shall have rivets driven in the valley of each corrugation and the rivets shall be spaced not more than 6 inches apart in transverse joints. The rivets shall be driven in such a manner that the sheets are drawn tightly together, so that they will completely fill the holes in the sheets and will have neat, workmanlike semispherical heads and shall be at least one inch from the edges of the sheets.

Field joints shall consist of bands not less than 8 inches in width. These bands shall be made from the same material as the pipe and shall be properly fitted with malleable cast iron lugs, provided with bolts not less than $\frac{3}{8}$ inch in diameter, in such manner that a secure and firm connection may be made.

Corrugated Iron Culvert Specifications

MATERIAL:—(a) The metal composing the Corrugated Pipe shall show an iron content determined by difference of at least 99.84 per cent pure iron; that is, the base metal shall not show more than .16 of 1 per cent impurities, namely, .11 of 1 per cent in the aggregate of carbon, manganese, phosphorus, sulphur, silicon, oxygen, hydrogen and nitrogen with not over .05 of 1 per cent of copper and must be of uniform and homogenous composition. A variation of not to exceed .02 of 1 per cent in the above mentioned total impurities shall be allowed covering the recognized analytical variations between expert chemists.

(b) All sheets besides being of the analysis as stipulated in the foregoing paragraph, shall be free from blisters, seams, slab or other foreign substances.

(c) All sheets must be of the gauge as represented, subject to the customary allowance of $2\frac{1}{2}$ per cent for variation, as per act of Congress, July 1, 1893.

GALVANIZING:—The metal shall be galvanized by the hot rolling process, the zinc spelter to be of the first quality and not less than two ounces to the exposed surface of one square foot of metal. The metal shall be galvanized before corrugated. Tests for weight of zinc spelter shall be made by the lead acetate method.

CONSTRUCTION:—All pipe shall be riveted and of full circle and with riveted seams and lap joints made tight. The rivets shall be guaranteed of the same analysis as the metal used in the manufacture of the culverts. 5-16" rivets shall be used in all diameters up to 48" inclusive, and $\frac{3}{8}$ " rivets for diameters larger than 48". On all culverts of a diameter under 30", there shall be one rivet in each corrugation and on all culverts 30" in diameter and over, there shall be two rivets in each corrugation. All rivets at circumferential joints shall be placed not more than 8" apart from center to center. Each culvert shall be made in one piece except when too long for economical handling, in which case sections shall be equipped with coupling bands.

TESTS:—Two pieces each not less than 4" square may be cut from any section of pipe so furnished, one to be tested by the purchaser and the other by the manufacturer after galvanizing has been removed. If said pieces are found by the purchaser to contain, contrary to the manufacturer's guarantee, a greater percentage of impurities than called for in the specifications, then a third party, who shall be a Metallurgical Chemist of recognized standing and satisfactory to both the first and second parties shall make a checking test from the two pieces in question. In case he finds the metal to be below specifications, then the consignment may be rejected without obligations by purchaser.

GAUGE OF MATERIALS:—The standard gauge shall be the United States Standard Gauge. (a) For all culverts under 30" in diameter the material shall be No. 16 gauge. (b) For culverts thirty (30) inches in diameter and not over forty-eight (48) inches the material shall be No. 14 gauge. (c) For culverts sixty (60) inches in diameter material shall be No. 12 gauge. For larger sizes than sixty (60) inches in diameter the material shall be No. 10 gauge.

Proposal—Bids for Corrugated Galvanized Culverts

To the of

We,, undersigned, by our authorized agent,, propose to furnish and deliver upon your order, f. o. b., cars, corrugated, galvanized culverts at the following net prices per lineal foot, and in accord with the following specifications and conditions governing manufacture and material:

Diameter.	Gauge.	Price per lineal ft.
10"	16	.....
12"	16	.....
15"	16	.....
18"	16	.....
20"	16	.....
24"	15	.....
30"	15	.....
36"	14	.....
42"	14	.....
48"	14	.....
60"	12	.....
72"	10	.....
84"	10	.....

The base metal composing culvert is known as
and manufactured by the, of
The culverts are manufactured by, of

CONSTRUCTION:—Style of culverts to be knocked down form or set up ready for installation.

Culverts to be riveted in full circle, and in continuous length or lengths, straight and in workmanlike manner.

MEASUREMENTS:—All diameters shall be the measurement on the inside of the culvert from the two closest points.

GAUGE:—All Gauges shall be in accordance with those set opposite the indicated price; United States standard to be recognized and furnished:

RIVETS:—All rivets to be used to be of

Rivets on 30" diameter and over to be inch thickness.

Rivets on 24" diameter and under to be inch thickness.

Rivets on 24" diameter and under to be singly or doubly riveted.

In every corrugation

In every second corrugation

In every fourth corrugation

Riveting to be straight

Riveting to be staggered

Rivets on 30" diameter and over to be singly or double riveted.

In every corrugation

In every second corrugation

In every fourth corrugation

Riveting to be straight

Riveting to be staggered

Circumferential riveting to have rivets not less than inches apart.

Depths of corrugations to be not less than inches.

Joint laps to be not less than inches.

Side seams or longitudinal laps to be not less than inches.

GALVANIZING to be spelter. Prime Western from virgin ore, or

Spelter to contain at least per cent pure zinc, and not over of iron.

Both sides of each square foot of sheets composing the culvert shall contain at least ounces of spelter.

All sheets to be first class, free from blister or signs of cracking.

BASE MATERIAL:—Base metal composing the culvert shall be not less than per cent pure iron taking into account all foreign substances, gases or metal alloys.

COMPOSITION:—The composition of the base metal shall be:

Carbon
Silicon
Copper
Oxygen
Hydrogen
Phosphorus
Manganese
Sulphur
Pure Iron
Nitrogen

100 per cent.

A good and sufficient surety bond issued by a responsible bonding company shall be furnished, guaranteeing the above analysis, and in default the purchaser shall retain payment until bond is delivered.

The purchaser reserves the right to withhold one-half the total amount of invoice of any orders shipped under these specifications until the tests and chemical analysis, herein designated, have been made; but with the understanding that such tests and analysis are to be made within sixty days from receipt of culvert shipment. Should it be found that the samples taken from the culvert do not come up to the specifications herein indicated as to purity and chemical analysis, the gauge and riveting as specified, balance due shall be forfeited by the company furnishing the culvert under these specifications, and all culvert received to become the property of the purchaser.

Any bidder, bidding under these specifications shall have the right to take the necessary sample from the culvert furnished under this proposal, and have analysis made to see that the material is in accord with the specifications, both as to gauge and material analysis. If any bidder finds that the specifications have not been complied with and so notifies the purchaser in writing

within thirty days after the delivery of the culvert, the purchaser may have the analysis verified by the proper authorities equipped for determinations of gases, and gauge verified by proper United States government department. Should it then be found that the specifications herein set forth have not been complied with, then the penalties hereinbefore described shall be assessed against the bidder furnishing the culvert, and all costs of verifications to be deducted from purchase price of the culvert.

The complaining bidder shall, with his complaint, furnish the purchaser a certified check in amount of one hundred (\$100) dollars to cover cost of analysis and verification, and cost of same to be assessed against the complainant if it is found that specifications as to gauge, riveting and analysis have been complied with.

The purchaser reserves the right to use more or less than the amount indicated in the estimate, at the herein named prices as accepted, provided the amount ordered shall not be less than a car lot quantity of minimum weight, 24,000 pounds.

As a guarantee of good faith and faithful performance of contract awarded on these specifications, a contract will be entered into, and certified check made payable to purchaser to accompany proposal, in amount equal to 25 per cent of the total amount to be purchased at prices herein shown.

Each bidder waives any rights, other than those mentioned in this specification and agrees to be governed by the foregoing.

Respectfully submitted,

By

Dated at, this the day of 19...

Accepted this the day of, 19...

By

Bridges

GENERAL DISCUSSION.

MR. FALLIS.—I am not very well prepared to discuss bridges offhand, except in a very crude way, but many things come to my mind in connection with the general subject of bridges which I think would be well to consider. There are, of course, a good many types of bridges in common use—wood, concrete and steel bridges, and various kinds of trusses, floors, etc., all more or less good, often very much less.

The first thing to do about a bridge is to get the foundation and build the abutments and head walls and piers. There are many classes of material for and kinds of foundations used in the State to a great extent—concrete, cut stone, cement rubble, dry rubble work and steel cylinder piers, and sometime abutments made of steel cylinders are used. The stone masonry bridge foundation has been used in the past to a greater extent than it will be in the future, on account of the popularity and security of concrete. The stone masonry pier or abutment is an economical structure compared to the plain concrete, but is not so easily built, nor so secure as concrete. The concrete foundation is better in every respect, if you get good concrete work, good

sand and cement, and experienced men to build it. I think one of the greatest troubles we have in the State in our construction work is failure to put men on work who know how to do the work they are expected to do. Inefficiency of the man used often causes the failure to get good results, and when he does not get satisfactory results sometimes the method or the material is blamed. Inefficiency is one of the chief troubles we have, and is frequently forced on us in the false guise of economy, and for reasons of political expediency. In the masonry abutment, as in every other abutment, the sub-foundation must be capable of carrying the weight of the abutment to be built, and in addition safely carry the superstructure and service loads. Foundations in all construction, and especially of the larger bridges, should be carefully built. A solid rock sub-foundation should be used whenever possible, or pile foundation built with a proper care for the loading can be used. Concrete piles can be used, and are recommended for such places where solid rock can be found at a depth not exceeding ten or twelve feet, and can be sunk through a rather firm soil to such rock. In using concrete for abutments or piers a large slab of concrete, say three or four feet thick, may be used to cover the pile—place it directly on the piles, and then build the abutment or pier on the slab; and it is not quite so important to have a continuous or solid pier on it, in the case of a pier, and we can distribute the pile heads considerably farther apart under a concrete slab like this than would be possible otherwise, or under any other kind of masonry work. Always be sure, however, that the piling remains wet at all times of the year.

The steel cylinder pier has been used a great deal in the State, but has never proven very satisfactory, and I would condemn the use of such piers without any exception. We can use the concrete pier at practically the same cost, and the stability of the concrete pier at this cost can be made much greater than the cylinder pier, and it is certainly more durable. There are several objections to the steel cylinder pier. The constant wetting and drying of the footing of this pier will soon cause this section of the pier to corrode and weaken. The foundation under a steel cylinder pier is very often insecure, frequently with only two or three piles at most under it, and with only the few square feet of area that it has to be carried on it is hard to get a satisfactory bearing. In some cases even the pressure from the wind brings a considerable weight on one side, and sometimes that comes from one direction much more frequently than another, and all those questions are to be considered. The weakness from inferior workmanship is often great. They are often filled with sand or only a semblance of concrete. In one of the western counties some time ago we took out the concrete cap that the bridge seat was on and found that the contracting bridge company had simply filled the cylinder with sand and put a concrete cap on the top. This pier had only been placed a short distance in the ground, but fortunately it touched the edge of a solid rock on one side. This was not sufficient foundation to support that bridge. Recently a county in the east made a contract for a small draw-bridge, and on visiting the site after three of the piers had been put in, I happened to get the opportunity of seeing the fourth one when placed. The contract called for the driving of four piles under each cylinder, but the contractor had found some old railroad scrap pile and gotten four pieces of 20-pound steel rails about six or eight feet long and had driven three of these under each cylinder in order to take the place of four piles specified. I reported the fact to the commissioners and they telegraphed the contractor

that they would not receive the bridge unless the pile foundations were properly put in.

A short time after that the War Department of the government required that we put fenders to the draw, in order to protect the passage of boats. After driving piles on the upper side of the bridge the foreman on the work put his pile hammer, weighing 2,000 pounds, on or over one of these cylinders and left it there that night. The next morning this cylinder had settled so that the draw would not close. So I do not believe it is good policy to use steel cylinder work at all. A concrete pier can be built at approximately the same cost, using 36" to 48" cylinders, with a 12" web between on a slab base foundation, three to four feet thick, at the average price of six to eight dollars per yard for concrete, using wood forms for this work, and they cost less money than concrete and steel forms for the same size steel cylinders.

In discussing wood bridges, I guess we all agree that the day of the wood bridge has passed. The price of lumber is high, and at best they are uncertain as to their safety; if it has any extended life to it, it must be a covered bridge, and I am satisfied we can approximate the cost of any covered wooden bridge with a steel structure that will give very much better results both in life and safety.

Concrete bridges have a great future in store, and are proper construction in a great many locations, but I would not approve of them in some cases. I believe they should be used wherever the traffic is heavy, as at points close to markets and cities, and wherever the amount and kind of traffic will justify the expense. I believe the concrete bridge should be used wherever the cost of the concrete bridge is low enough to make it a good business proposition. To illustrate: in one of our counties somewhere near \$100,000 was spent for a bridge on a road that has no considerable amount of traffic, and in no way justified this expense. They should have divided this amount up into several good steel bridges or a good steel bridge at this location, and the interest on the money thus saved would have replaced this bridge about every six years, or saved to the county this amount. We can use I-beam bridges over short spans very easily, and very economically. We can buy these I-beams at rolling mills, priced f. o. b. our nearest railroad station, or the bridge companies will furnish them ready for erection. I-beam bridges can be used over longer spans than is usually indicated by the bridge companies' designs. I have used I-beams 15", 42-pound beams on a 40-foot span that did not give too much deflection, and did not have too much vibration, and they were perfectly safe under any load that would ordinarily come over them. They can be built very economically by local labor, under the supervision of the county engineer and the superintendent of road forces in the county. When we have to use the longer span of bridge the steel truss bridge in its various forms should be used. I always use a "pony truss" bridge on spans up to 75 or 80 feet. This on a low truss not running over eight or nine feet high, and has no connecting members between the trusses overhead. By the use of this truss we get rid of the excessive or troublesome upkeep of the higher bridge, so far as painting the high truss and examination is concerned, as this matter, especially the painting, should be looked after carefully. I would use a riveted truss of this length, because it is short and light, and easy to erect, and for that same reason I would rather have a pin truss for all spans over 100 feet, because of the ease and rapidity of the erection, and the difficulty of securing proper field riveting on the higher trusses.

In bridge floors, I believe that the flooring of the bridge, when of wood, should always be of three inch material, and always sized. I think the economy of using a sized floor is a great deal more than people usually consider. It reduces the vibration on the bridge. It makes it more pleasant to drive over, and increases the life of the floor itself. I am sure a three inch floor is more economical than a thinner floor for the reason that we have greater strength in the floor to begin with. We can allow that floor to wear and decay more than a thinner floor before becoming unsafe, and it will last longer. As a safe floor, concrete is very much more desirable as a floor material than wood, and in a few years this floor promises to be as cheap to build as a wooden floor, and the concrete floor has several advantages, I believe, over the wooden floor, which is rapidly becoming more and more expensive. I believe it will tend to preserve the floor joist, because if properly constructed and waterproofed there will be less chance of corrosion under a concrete floor if well built, and it can be made practically water-proof by a bituminous or other coat on top before putting wearing surface on it.

Another point in regard to the painting of the bridges: It is rare that a bridge built under a county commission is properly painted. I inspected a short time ago a bridge painted for a county under a bridge company's instruction, care was not taken in cleaning the rust from the steel and at least two-thirds of the paint came off because of rust being left underneath the paint. We took chisels and hammers, cleaned it off thoroughly and painted it with two coats of good graphite paint, and after that compared the cost of double coat together with the cleaning and the bridge company's charge for their inferior work, and we were still \$100 to the good.

If the counties in the State would all secure competent engineering advice in the construction and maintenance of all road and bridge work in the State, they would save enough money to pay the salaries of all the county officers in the average county of the State.

The following letters, with bridge specifications, were distributed at the institute:

Bridge Specifications and Letters Regarding Same Distributed at Institute

TARBORO, N. C., January 21, 1915.

DR. JOSEPH HYDE PRATT, *Raleigh, N. C.*:

DEAR SIR.—We wish to submit an illustration showing the value of engineering services in bridge work. It became needful to repair the Tarboro bridge in this city. We employed one of the Survey engineers, Mr. W. S. Fallis, to advise us in regard to the matter. After an examination the engineer advised immediate repairs and furnished contractors with needed information to bid on same. The lowest bid was for the sum of \$5,200. The engineer advised that the bid be not accepted and that a competent bridge erector be employed to do the work under his supervision. This our board did and we secured the required repairs in a complete, first-class workmanlike job for the sum of \$2,541.91, saving to our county more than half of the amount that we would have been forced to pay to the bridge company if we had not employed an engineer to advise us in the matter.

We give this information from actual experience, and hope that it will be of service to you in convincing the different boards of county commissioners

in our State that we found it much more satisfactory than letting the work out by contract, as we get better paint and better and more satisfactory work in every way.

Yours most respectfully.

(Signed)

R. B. PETERS,

Ex-Chairman Co. Com. Edgecombe County.

Austin Bros., \$5,300.

Roanoke Bridge Co., \$5,200; without paint, \$4,300.

TARBORO BRIDGES.

Pay rolls	\$86.87	Not in contract.....	\$86.87
Pay rolls	77.24		
Pay rolls	74.84		
Pay rolls	206.15		
Pay rolls	108.50		
Pay rolls	115.75		
Pay rolls	232.65		
O. F. Yornst.....	18.00		
O. F. Yornst.....	25.00		
O. F. Yornst.....	100.97		
	<hr/>		
	\$1,045.97		
Watchmen	\$86.30		
Watchmen	39.65		
	<hr/>		
	125.95	Not in contract.....	125.95
Supplies:			
Tarboro Hdw. Co.....	\$16.53		
T. F. Marrow, Agt. Frt..	72.20		
D. Lichtenstein Co.	1.25		
Marrow-Plitt Hdw. Co. ..	4.00		
Frt. Cement & Rock....	56.01		
Rope Pull	12.90		
Freight	58.35		
Tarboro Hdw. Co.	48.10		
Smith-Courtney Co.....	33.72		
C. P. Lathrop, Rock.....	125.02	Not in contract.....	125.02
L. R. & W. G. Sugg.....	36.18	Not in contract.....	36.18
J. Dixon Crucible Co. ...	128.70		
King Bridge Co.	463.11		
Tarboro Hdw. Co.	47.47		
Jameson McK. & Evans..	208.36		
S. Courtney & Co.	2.20		
L. R. & W. G. Sugg.....	21.65		
J. Dixon Crucible Co. ...	128.70		
Freight	4.86		
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	1,472.31		
W. S. Fallis.....	\$62.10		
W. S. Fallis.....	279.20		
	<hr/>		
	341.30		
	<hr/>		
	\$2,985.53		

Lumber, J. E. Harris....	\$104.01		
Lumber, E. T. Warren..	53.39		
Lumber, E. T. Warren..	325.00		
Lumber, E. T. Warren..	180.24		
		\$ 662.64	\$ 662.64
		\$3,648.17	\$1,106.66
		1,092.69	
		\$2,555.48	
\$5,200.00			
2,555.48			
\$2,644.52 saved.			

GEORGE L. AUSTIN, Atlanta, Ga.

FRANK E. AUSTIN, Dallas, Texas.

AUSTIN BROTHERS,
Steel Bridges and Structural Work.

Office and Yards:
Greenwood Avenue and Southern Railway.
Near Ponce DeLeon Springs.

GREENSBORO, N. C., January 28, 1914.

TO HON. BOARD OF COUNTY COMMISSIONERS, for *Edgecombe County N. C.*:

GENTLEMEN.—We will furnish material and labor and put in place the repairs to the steel bridge over Tar River as set out by your engineer for the sum of fifty-three hundred (\$5,300) dollars. Should this proposition be accepted we would require your engineer to go over the bridge with our engineer and make a detail specification as set out in his specification memorandum, and have his O. K. to them before we would sign contract.

Yours truly,

AUSTIN BROTHERS.

(Signed)

By C. W. CURRY, Agent.

ROANOKE, VA., January 24, 1914.

HON. R. B. PETERS, *Chairman Board of Commissioners, Edgecombe County, Tarboro, N. C.*:

DEAR SIR.—We, the Roanoke Bridge Company, Incorporated, Roanoke, Va., propose to furnish and erect all necessary material for repairing the steel drawbridge over Tar River, at Tarboro, N. C., as per specifications prepared by Mr. W. S. Fallis, Civil Engineer, which are attached and made a part of this proposal for the work, as follows:

We hereby propose to furnish and erect complete new bottom chords for the single span. These chords to consist of two lines of 7" channelslaced. Two lines of "I"-beam floor joists, consisting of 7" beams, 15 pounds per lineal foot for each joist throughout the entire length of the bridge. One reinforcing plate 6 x 20' 0" long, to be riveted to the top flange of the 15" floor beams where needed. We hereby propose to furnish and erect the necessary sidewalk brackets at the end of the floor beams which will have to be repaired.

We will furnish and erect the material as stated above and as per the specifications by Mr. Fallis attached, for the sum of \$4,800.

We hereby agree to furnish all material and do all necessary work as per above specifications and give the entire structure one new coat of standard bridge paint for the sum of \$5,200.

If awarded the contract for repairing the above bridge, we will commence work within ten days from receipt of order and rush same to as early a completion as possible.

Inasmuch as we have just completed certain repairs for the above bridge, we feel that we are in a position to know just what is needed to repair the old structure and make it safe and solid for future traffic.

Hoping to be favored with this order, we remain,

Yours very truly,

(Signed) ROANOKE BRIDGE COMPANY, INC.
H. F. GAY, Manager Highway Department.

CURTIS AND THORNTON COMPANY,
Engineers and Contractors Steel Bridges.

HICKORY, N. C., August 18, 1913.

W. S. FALLIS, C. E., *Franklinton, N. C.*:

DEAR SIR.—We propose to furnish and fabricate and deliver at Hickory, N. C., the metal required for the bridge at Brookford, near Hickory, N. C., in accordance with the plan herewith submitted for the sum of \$2,37½ per hundred pounds. Or, will fabricate and deliver all metal required at Hickory for the lump sum of \$1,195.

Respectfully submitted,

(Signed) CURTIS-THORNTON COMPANY.
R. W. CURTIS.

HICKORY, N. C., February 12, 1915.

DR. JOSEPH HYDE PRATT, *State Geologist, Chapel Hill, N. C.*:

DEAR SIR.—As a member of the Hickory Township Road Commission, I wish to thank you for recommending Mr. W. S. Fallis to us as engineer. We have found him extremely satisfactory in the work he has given us, and in one point particularly he has saved us quite a sum of money. We had an old bridge across the South Fork River to take care of, and found it necessary to raise and widen it. We took the matter up with the representative of a bridge company who has had quite a great deal of experience here in the South, and with Mr. Fallis. After considering the matter, we took the latter's plan and rebuilt the bridge at a saving of \$529 over the best bid (\$1,195) that we had from the bridge company. We think that this itself shows the value of a good engineer to any road commission.

We trust that you will be able to see the State Highway Commission bill go through the Legislature, and give all the counties the benefit of good engineering service.

Very truly yours,

(Signed) G. H. GEITNER,
Chairman Hickory Township Road Commission.

Use of Explosives in Road Work

By J. H. SQUIRES, Agronomist,
E. I. du Pont de Nemours Powder Company.

When we consider the mileage of road being built or repaired annually in North Carolina and estimate the enormous cost of the work, it at once be-

comes evident that any saving, no matter how small a percentage, on the different jobs will amount to a large sum in the aggregate, sufficient to build a considerable increase or to keep many miles in excellent repair.

Direct savings are resulting in all cases where there is a replacement of hand labor by improved methods, such as suitable machinery and high explosives.

It is the purpose of this paper to give some idea of the different grades of explosives suitable for highway construction and some information regarding their uses. The best results can be obtained only by the selection of the proper grade and strength of explosives and by employing the best known methods of handling and loading.

For general road work the explosives used range from black powder to the strongest dynamite. Black blasting powder has been in use longest; it is chiefly employed for loosening certain classes of tight clays or loose rock and a few still prefer it for rock cuts. It is not water resisting and requires more careful handling than the lower strength of low freezing dynamite, which are rapidly replacing it.

Powders of the Judson type have also been in use for highway construction for a long time. In practical use they are loaded in much the same way as blasting powder, than which they are more water-resisting and faster and more shattering in their action. They are, however, slower and less shattering than dynamite. All of the Judson type powders, now known as low powders, are reasonably low-freezing. When frozen it is necessary to thaw the F, FF and FFF grades, but if the lumps of R. R. P. are thoroughly crumbled in the hand before loading, thawing is unnecessary.

The selection of dynamite for the different classes of highway work permits of the widest variation on account of the various strengths and the characteristic qualities of the different grades. Later, mention will be made of the application of the different strengths and grades.

Some of the principal uses of explosives for highway construction are clearing the right-of-way, ditching the roadbed, loosening soils for reducing grades, excavating cuts and breaking up stone for surfacing material.

In clearing the right-of-way in this State the chief obstacles are stumps. These are now ordinarily removed by hand labor, a slow and expensive method, no matter what kind of labor is used. If it is hired labor the cost is high, and if it is convict labor it is taking up valuable time that might more profitably be used where there is other work requiring hand labor. A cheaper, quicker, more satisfactory method of removing these stumps is by blasting. For this work a low-freezing extra 40 per cent dynamite is usually found more satisfactory except in very loose sandy soils where a quicker acting 50 per cent or 60 per cent straight N. G. dynamite will give better results. In loading the effort should always be to get the stump on the first blast because it is difficult to blow out a stump after it has been shattered by a poor blast. The chief trouble is loading too shallow. The bore hole under a stump should be deep and well under the part offering the greatest resistance, which is usually near the center of the stump. When large stumps are encountered several bore holes should be used so that the charge may be distributed under and around the large roots. When such loading is practiced, electric firing must be used. Often in cuts heavy loading will have the additional advantage of excavating a considerable amount of ground along with the stump and hasten the cut work.

For blasting boulders from the right-of-way it will usually be advantageous to place the charge in a hole punched under, but immediately against the bottom of the boulder. For such loading the explosives advised for stumping will be found to give entire satisfaction. When mudcapping is practiced this low-freezing extra 40 per cent may be used on easily broken stone or where there is little work to do. On the hard nigger-head boulders, most often found in this State, it will be better, especially if there is much of this work to do, to use either 50 per cent or 60 per cent straight dynamite, as the action is more shattering. It should be remembered that straight N. G. dynamite is not low-freezing and should be carefully handled in cold weather.

These two methods of blasting boulders require but little labor, however, the amount of explosives needed is considerably greater than if a hole is drilled into the boulders and the dynamite securely tamped into the bore hole.

In grading, where cuts are made in hard rock, a good all-the-year powder is the low-freezing dynamite mentioned above. When the cut is in loose rock the strength may be anything from 20 per cent to 40 per cent. If it is tight soil from 20 per cent to 30 per cent. In hard rock, 40 per cent is usually preferred.

Much work is now being done in widening cuts in improving old roads. The side slope is usually too steep to use teams, and pick work is expensive. Such side slopes may be loosened and thrown on the old road by blasts of low-freezing 20 per cent dynamite or Farm Powder or Low Powder, F or FF, placed in a line of holes spaced a little way back from the brink of the cut and fired electrically. This will put the soil in good shape at a place from which it can easily be removed with scrapers.

After many miles of country travel, I am convinced that the greatest drawback to country roads today is bad drainage. We need not only a well rounded surface and a pair of side ditches, but also a means of discharging the water from these side ditches. Such discharge or outfall ditches are always at the lowest points and often through swampy or stumpy ground. Former difficulties in ditching such material caused the drainage to be neglected and the roads have suffered as a consequence. The average cost of digging swamp ditches with dynamite has been about 10 cents per cubic yard. The methods are simple and no expensive outlay for equipment is needed. When the work is through wet soils and a large ditch is desired, the best and most satisfactory results are obtained by using 50 per cent or 60 per cent straight N. G. dynamite, detonating an entire line of ditch with a single cap and fuse, depending on the shock from the one primed hole to discharge the rest. When the soil is dry this method will not work, and a lower strength dynamite, preferably low-freezing, is used and detonated electrically. In the first case the bore holes are spaced from 18 inches to 24 inches apart, but in the latter the distance is increased to 24 inches or 32 inches for small ditches and for large ditches may be as great as 48 inches.

The exact limitations of this method of ditching have not as yet been worked out but ditches up to 18 feet wide and 9 feet deep have been economically blasted, although it is not generally advised to undertake ditching deeper than 5 feet or 6 feet. In changing stream courses to protect bottom roads, this method is found to be wonderfully successful in straightening the streams and in removing stumps, rafts and boulders from the channel to permit a freer flow.

In shattering field boulders to get surfacing material the methods of load-

ing and explosives already recommended for clearing the right of way will be found to be the best. Often a temporary or permanent quarry may be opened up to better advantage, in which case the handling of the face will be of material moment in the cost of the stone. The face should be kept as straight and even as possible and it is usually best to have the holes drilled the full depth of the face. For most of the stone in North Carolina a low-freezing extra dynamite of 30 per cent to 50 per cent strength will be found best.

In digging post holes in different classes of soils along the roadside, two methods are employed. In one, a slow low freezing powder is fired in small amounts in the bottom of the hole and the loose soil is shoveled out. In the other small charges of 40 per cent to 60 per cent dynamite are tied to a stick and distributed along the bore hole and fired from a single cap in the top charge. This will be found to force back the soil and reduce cost and time to a minimum. Better results will be obtained if the top of the hole is excavated by hand to a depth of 6 or 8 inches before the blast is fired.

Frequent mention has been made of low freezing explosives, the use of which not only hastens work in frosty weather but gives better results and overcomes the dangers due to careless thawing, because these explosives are frozen only in the coldest weather in this State.

DISCUSSION.

Question: What method do you advise for thawing dynamite?

Answer: For small amounts use only an accepted type of thawing kettle. For larger amounts an unopened case can be buried in green manure the day before the explosive is needed. The heat produced by the fermentation of the manure will be sufficient to thaw the dynamite. Never thaw dynamite around the forge or before fire or in hot ashes or sand.

Question: About how much burden should be taken in blasting out a rock cut?

Answer: For shallow work put the holes back from the face about as many feet as the cut is deep and drill the holes a little below the sub-grade. Space the holes about the same distance apart and load them from one-half to two-thirds full. For cuts deeper than 6 feet the burden and space should not be over 6 or 8 feet. Good tamping is essential.

Question: What about water tamping?

Answer: Water makes excellent tamping in wet work, but is seldom used in dry work, as moist clay makes excellent confining material and has the additional advantage of not wetting the dynamite and detonator.

Question: How would you handle a hole in hard rock when the cap and fuse had failed to detonate the charge?

Answer: Would wait a safe length of time to avoid any delayed explosion due to a slow-burning or damaged fuse, preferably until the next day, and then remove the tamping with a hard wooden stick for loosening and a "spoon" for taking out the dirt. When close to the charge would put in another primed cartridge, retamp, and allow this second detonator to detonate the old charge. Sometimes it will be found necessary to put down a new hole about two feet away from the old hole and load it sufficiently heavy to blow out the burden. A good preventive for such miss fires is to use only electric caps, using two in each hole, one in the bottom and the other in the top, when the charge is heavy. Do not use weak exploders if you want the

best effects from your blasts, nothing weaker than a No. 6 blasting or electric blasting cap is advised, and it is very apparent that the larger sizes will soon be adopted for all general blasting.

Question: How much mud would you use on a mudcap?

Answer: As much as possible, the more the better. Not less than a depth of 6 inches if the best execution is desired.

Question: What is the limit of length for a ditch fired in wet soil with one cap using 60 per cent dynamite?

Answer: I know of no attempt longer than half a mile. This effort was a complete success.

DR. PRATT. Men have been using powder as many farmers use fertilizers; buy it because it is recommended by some one else who had particularly good results, not knowing whether or not it was what they needed. Mr. Squires, of the Dupont Powder Company, is going to take up the different grades, what one is good for.

MR. PETTON. I have found that our work being contract work did not affect me materially as to the material used. I have been really annoyed, however, that in many instances they have used dynamite when they should have used powder and *vice versa*. The effects of the two materials were very different.

Another waste that comes in: a man doing explosive work, not knowing how much of a charge to make, but wanting to be sure to get enough, will very often put in twice as much as is really needed to accomplish the results he wants. This not only causes a waste of powder, but often damages surrounding property.

The following papers referring to sand and oil surfacing and instructions to patrolmen were distributed to the institute:

Sand and Oil Surface

(Layer Method).

SHAPING SURFACE FOR SAND AND OIL.

SECTION 9. Before the sand and oil is spread, the roadbed shall be shaped to a true surface conforming to the proposed cross section of the highway and rolled by a six-ton roller, unless otherwise ordered by the Engineer.

All depressions occurring must be filled with suitable material and again rolled until the surface is smooth and hard. The cost of shaping and rolling the roadbed shall be included in the price paid for excavation and for furnishing the material used, and shall not be additional thereto.

When, in the opinion of the Engineer, it is necessary to place hardening material on the subgrade of the road, before the sand and oil is laid, the Contractor shall spread clay or other material satisfactory to the Engineer and roll the same in such manner as is satisfactory to the Engineer, and with such weight of roller as he may direct.

SECTION 10. Upon the roadbed prepared as described in Section 9 shall be applied asphaltic oil by the layer method, if so directed by the Engineer, for a width of sixteen (16) feet, by means of a distributor, so arranged as to enable the operator to control the flow and distribute the oil equally and uniformly, leaving no spots or streaks uncovered and to avoid spreading a

surplus of oil at any point, and to completely control the quantity of oil delivered on the road.

The oil shall be spread on the road at a temperature not greater than 250 degrees F., and not less than 180 degrees F., and shall be so heated as to insure its delivery on the road at the required temperature.

There shall be three applications of oil, the quantity for each application to be on the average not less than two-thirds ($\frac{2}{3}$) of a gallon per square yard.

After the first application of oil has been made and as soon thereafter as the Engineer may direct, a layer of sand shall be uniformly spread thereon of sufficient depth to insure a thickness of approximately one (1) inch after rolling.

As soon thereafter as the Engineer may determine, the second and third applications of oil and sand shall be applied in the same manner as in the first application and to the satisfaction of the Engineer.

After three layers of oil and sand have been applied, in the prescribed manner, the road shall be rolled by a roller of such a size and weight as the Engineer may determine.

During the rolling, sand shall be applied to absorb any oil which may flush to the surface, and in such quantities as the Engineer shall direct.

After the rolling has been completed to the satisfaction of the Engineer, a thin layer of sand shall be spread evenly over the entire oiled surface.

All sand shall be clean, sharp and free from loam, clay and adventitious matter of all kinds and shall meet with the approval of the Engineer.

All depressions in any course shall be filled with the same material used in that particular course and shall be rolled until a smooth, true and unyielding surface is obtained.

If at any time before the acceptance of the work any sort of imperfect places or spots shall develop in the surface, the material at all such points shall be removed and replaced with new material and then rolled until thoroughly compacted, and until the joints or edges at which the new work connects with the old become invisible.

All removal and replacement of unsatisfactory material shall be done at the expense of the contractor.

No bituminous work shall be done during rainy weather nor when weather conditions as to temperature or otherwise, are, in the opinion of the Engineer, unfavorable to obtaining satisfactory results.

The Massachusetts Highway Commission will furnish all asphaltic oil necessary in tank cars at the railroad freight station nearest to the site of the work.

The Commission will order the oil when requested so to do by the Contractor.

BITUMINOUS SURFACE.

(Sand and Oil Mixed).

SECTION 10. Upon the roadbed prepared as described in Section 9, the sand and oil surfacing shall be applied as follows:

The sand and oil shall be mixed by hand, or with a mechanical mixer, or by other means furnished by the Contractor, provided the method employed is approved by the Engineer. If the mixing is done by hand, it shall be done on tight platforms, to be furnished by the Contractor, the platforms to be

made of two (2) inch plank, about sixteen (16) feet in length, and in two sections, each about four (4) feet in width.

The Contractor shall furnish and operate at least four (4) mixing platforms and four (4) heating kettles or tanks, and a sufficient number of sand heaters, and if in the opinion of the Engineer the work is not proceeding with sufficient rapidity to insure its completion within the time specified in the contract, the Contractor shall furnish and operate a sufficient number of additional platforms, kettles, and sand heaters to insure the work being so completed within the time specified.

The kettles or tanks for heating the asphaltic oil shall be of a design satisfactory to the Engineer, and of a capacity of not less than sixty (60) gallons each.

The sand shall be dry and so heated that when mixed with the oil a uniform mixture will be secured. Care must be taken not to overheat the sand so as to burn the oil.

The sand and oil shall be mixed in batches of approximately one (1) cubic yard, the sand being spread upon the mixing platforms and the hot oil poured upon it and the whole mass thoroughly turned with shovels, hoes, or rakes, until each particle of sand is completely covered with oil, about sixteen (16) gallons of oil being required for one (1) cubic yard of sand as measured loose in measure box.

The oil when mixed with the sand shall be hot enough to secure a good mixture, and shall be of a temperature between 250 degrees F. and 375 degrees F., depending on nature of oil used.

When the mixing is completed to the satisfaction of the Engineer, it shall not be dumped upon the subgrade, but it shall, without delay, be spread while still warm upon the subgrade from a dumping board, or from a plate of sheet iron satisfactory to the Engineer, to a width of sixteen (16) feet and to a depth of three and one-half ($3\frac{1}{2}$) inches at the center and sides, after rolling with a tandem roller weighing approximately six (6) tons.

After the mixed material is deposited in place and shaped with rakes, etc., it shall before it hardens, be rolled with a horse roller weighing about one ton, then shaped with a road machine or with a suitable scraper and afterwards rolled with a tandem roller to the satisfaction of the Engineer. A hand roller weighing about 200 pounds may be used before rolling with the horse roller, if preferred.

If any depressions appear after scraping and rolling the sand and oil mixture, suitable mixed material satisfactory to the Engineer shall be added. If such depressions are found after the sand and oil has hardened so that the new mixture will not readily bond with the old, the old mixture shall be dug out to a depth satisfactory to the Engineer and the new material added.

Any slight unevenness of the surface shall be remedied by scraping with a road machine or a suitable scraper, and the surface shall then be rolled in a manner to remove all such depressions and leave a smooth and even surface.

After the sand and oil mixture is rolled to a firm surface, free from all irregularities and all surplus loose material, a seal coat of asphaltic oil shall be distributed in two applications at the rate of one-quarter ($\frac{1}{4}$) of a gallon per square yard of road surface for each application. Each application of

oil so applied shall be uniformly covered with a thin layer of sand and rolled to the satisfaction of the Engineer.

The asphaltic oil, when applied to the road surface, shall have a temperature approximately 250 degrees F.

If so ordered by the Engineer, the thickness of the sand and oil mixture shall be increased or diminished at such points as he may direct.

The sand shall be clean, sharp and dry, free from loam, clay and adventitious matter of all kinds. It shall contain no stones larger than one-half ($\frac{1}{2}$) inch in their longest dimensions, or practically any grains or particles which will pass through a screen of fifty (50) meshes to the lineal inch.

The finished surface of the road shall present such crown as shall be directed by the Engineer.

In distributing the oil no overlapping shall be allowed.

The Contractor shall sprinkle the road with water when and as directed by the Engineer.

All depressions in any course shall be filled with the same material used in that particular course and shall be rolled until a smooth, true and unyielding surface is obtained.

If at any time before the acceptance of the work any soft or imperfect places or spots shall develop in the surface, the material at all such points shall be removed and replaced with new material, and then rolled until thoroughly compacted, and until the joints or edges at which the new work connects with the old become invisible.

All removal and replacement of unsatisfactory material shall be done at the expense of the Contractor.

No bituminous work shall be done during rainy weather nor when weather conditions as to temperature or otherwise, are, in the opinion of the Engineer, unfavorable for obtaining satisfactory results.

The Massachusetts Highway Commission will furnish all asphaltic oil necessary for mixing in barrels and for sealing coat in tank cars at the railroad freight station nearest to the site of the work.

The Commission will order the oil when requested so to do by the Contractor.

The Contractor shall be responsible for any and all railroad storage charges and for any loss or damage to material that may accrue after the delivery of the oil at the railroad delivery selected.

The Contractor is to heat the oil in tank cars or otherwise, team the oil to the site of the work, and apply thereon as specified, without compensation additional to the price paid per square yard for bituminous surfacing.

General Instructions to Patrolmen

Inspect your road, its entire section, during a rainy day and locate all pond holes.

Use the road drag immediately after a rain.

Fill all depressions with good material.

On no account use wornout material, sod or sand from ditches.

Remove all glass, tin cans, nails, old iron, etc., from the roadbed.

Renew all defective plank at culverts when necessary.

Should your road surface be very rough, a spike-toothed harrow used while the road is wet will improve an earth, sand-clay, topsoil or gravel surface.

Cut the weeds both sides of the road. Use a mowing machine for this purpose if practical.

Cut all brush at inside of the curves and at railway crossings and culverts.

Remove the ridge between the wheel rut and the gutter by using the one horse cultivator and then use the drag to push the material toward the ditch.

See that all culverts are clear, with outlets and inlets in good order.

Paint all guard rails at culverts and bridges, etc.

Renew all signboards, mileposts, etc., when necessary and give the traveling public all the advice in regard to the routes within your power.

See that all labor and teams in your employ render full and satisfactory service.

Receive all information and criticism from the general public in a courteous manner.

D. H. WINSLOW,

United States Superintendent of Road Construction, Hotel Malbourne, Durham, N. C.

FRIDAY MORNING, FEBRUARY 26.

Relations That Should Exist Between State Highway Commission, County Highway Commission, and Township Highway Commission, and Relations of Highway Engineers to These

ORGANIZATION OF ROAD FORCES.

DR. PRATT.—In discussing this subject I am taking it for granted that that State has a State Highway Commission, and in North Carolina the bill creating a State Highway Commission has passed the House and is now before the Senate, and we do not anticipate any serious trouble or difficulty whatever in having that bill passed by the Senate; we are therefore almost certain of having established by this General Assembly a State Highway Commission. We now have in many counties throughout the State the road work under the county commissioners. In several of the counties, however, there have been created and established what are known as highway or road commissions, and these have been established with a membership varying from three to thirty-six members. Now there is no doubt that when a commission composed of three to five members has full charge of the road work, the efficiency of the road work in that county or township is handicapped. As you increase the number of commissioners the tendency will be to decrease the efficiency of the road work. I would prefer, I think, in almost any county or township that the commission should not consist of over three men, and that such a commission be appointed regardless of politics, the members being appointed because they are men who are interested in the development of their county and are willing to give a certain amount of time to the road work. It is unfortunate if we are not able to have the county as the unit and thus have a board of road commissioners for the county, for when the township is the unit it means usually separate township commissions. Thus in many cases where there are many townships, we have instead of one road commission, anywhere from three to five or ten township road commissions, each separate and distinct. This means that the efficiency of the road work in the county will be decreased. In other words, your county as a county will not have in the end as good a system of roads even with the same

amount of money or as many miles or as economically built roads as it would have obtained if the money was expended with the county as a unit and under a board of road commissioners.

Now there should be a relation—a direct relation— between a state highway commission and a board of county road commissioners. We cannot get the full, close relationship between these commissions until the State is in a position to offer assistance to the county in actual road construction. That is, the State should make appropriations for the actual construction of roads in the counties or give to the county a certain number of State convicts maintained at the expense of the State to be used in road construction work. The proposed State Highway Commission for North Carolina simply contemplates giving to the counties engineering assistance, but only giving it to those counties that make request for it. If, however, we could give the counties actual assistance in construction work, we would then be able to bind the two commissions very close together, because I think when the time does come that we are able to give such assistance in the way of construction work, there will be a clause in the State Highway Commission bill that will make the State Commission responsible for the construction work, for the maintenance of the road after it is built. On the other hand, the county must obligate itself if it receives such assistance to have the road built as determined by the State Highway Commission and maintained as the State Highway Commission directs.

I hope some day we will see in North Carolina the roads of the State divided into three classes:

1. The inter-county or State roads. The State has already authorized the location and construction of the Central Highway across North Carolina, to be known as a State road, the Raleigh-Salisbury Highway, the Wilmington-Charlotte Highway, and the Hickorynut Gap road—all known as State roads—inter-county roads. I hope some day to see North Carolina taking over these State roads so they will be entirely under State supervision, the State paying the whole maintenance cost of same. We are going to have a large fund in the way of the automobile tax, all of which should be used by the State in the maintenance of the public roads.

2. The second class will comprise inter-township or community roads, which should be constructed and maintained by the counties. These roads are important to the county as they connect the various townships with each other and with the county seat, and are the feeders to the State roads.

3. The third class of roads are the township roads, which are of primary importance to the township and of great value in its development and should therefore be built and maintained principally at the expense of the township.

Now, 95 per cent of the traffic of the State and county will pass over the State and county roads. There will probably not be over 5 per cent of the traffic that will go over the township roads, the third class of roads, which are simply community roads often used by only one or two families.

While it may be some time in the future, yet I believe such a system will come to North Carolina as it has come to Massachusetts and other New England states, the Middle West, New Jersey, New York and other states. There is no reason why we should not have such a system here. It is worked out in the other states similar to the way the department of education is worked out here in North Carolina. We have our State system and all the school work is directed under the supervision of the Department of Education, but

we have the county work, the township and city school work—all under the supervision of the central office at Raleigh, the State Board of Education.

At the business meeting last night I made the statement that it seems from the discussions we have had here thus far, we are not paying any particular attention to the road and street work of our cities and incorporated towns, and this is true; but the State Highway Commission when it has reached its fullest development, as I think it will two years from now, will be in a position to give assistance to those who have charge of our street work.

We are unfortunate in North Carolina in permitting towns with a population of a few hundred people to become incorporated towns. As soon as incorporated, it passes out of the jurisdiction of the county commissioners and road commissioners and becomes a corporate body by itself. It then has to raise all its own revenue for street work and for every other development that goes on within its borders unless by some special act of the Legislature the county authorities are authorized to do certain work in that town. Illustrations: Elon College, Gibsonville, Carrboro, etc. The counties of Guilford, Alamance and Orange have not been able to build a county road through those incorporations; consequently, when we have tried to build through highways, those three towns have stated that they did not have money with which to continue roads through their towns. Sometimes it is not practicable to build around the incorporated villages and, as in the above three instances, there are several sections of road one-half to one mile in length that have not been built. I am hoping that in some way or other we will be able through the State Highway Commission and legislation to be able to assist incorporated towns of less than a certain population in building the main highways through such towns. I cannot see any reason why a small collection of people cannot, without incorporating themselves, obtain all the benefits that they expect to gain through an incorporation. In New England, two years ago, I went over hundreds of miles of road in Connecticut, Rhode Island, and Massachusetts. They have little villages, not incorporated, with just the same kind of protection—police duty, lighting apparatus, etc.—as little incorporated towns in North Carolina, and yet they get all the benefits that the county and township get down here through the board of county or road commissioners. And roads there do not stop the minute they reach a little village; they go straight through, whether State, county or township roads.

Now, I want to take up briefly my idea of the relation of the highway commission to the engineer, whether it be a state highway commission or a county highway commission or a township highway commission. I have illustrated on the accompanying chart my idea of the relation that should exist. The highway commission works through the highway engineer. If the best results are to be obtained in the road work in any county or township, the commission must employ a competent road engineer and then give him complete charge of the road work in the county or township. Every other man on the road force is appointed by the engineer, with the approval of the highway commission; and the engineer has the right to discharge any man who does not carry on the work as laid out by him. The method of procedure of the work is not done by the highway commission through rules and regulations to these men, but is done through the road engineer. If the road work is done as outlined above, you can get good results, otherwise you are not apt to, and this is well illustrated in many North Carolina counties where the com-

mission has tried to instruct the engineer how to do his work and have had the authority to go contrary to his directions.

There have been two counties in North Carolina where the superintendent of the convict forces was not subject to the highway engineer, but to the highway commission. In both cases the engineer resigned from the county because the superintendent refused to do the work as outlined by him. The superintendent had his own ideas as to how the road work should be done and insisted on doing it his way. The superintendent of the convict force must be subject to the engineer and not to the commission except through the engineer. In the cases cited the superintendent had been appointed for political reasons, and therefore must not be removed. In a county where the road work is not very large the engineer may be also the chief superintendent of construction. You may combine the two positions in one man, and still the general plan for the organization and the relation of the engineer to the commission does not change. The point I want to emphasize particularly is that the road engineer must be in charge of the work.

Just a word in regard to the purchasing agent. Any supplies that the highway commission expects to purchase must be approved by the road engineer before the contract for such supplies is made. That may seem as though you were conferring upon the engineer extraordinary power, but every single purchase that is made for supplies to be used in road construction has a direct bearing upon the cost per mile of that road. You put your engineer in charge to get the best results, with a certain amount of money, in the way of mileage of roads in your county. If you go ahead and permit the highway commission, without any reference to what is needed, to purchase the road machinery, mules and carts, and other supplies to be used directly in connection with the roads, you may be running your cost account up many thousands of dollars more than it ought to be. Let me illustrate by what happened to a county in Tennessee. Recently I met three men whom I know very well, who represent three of the road-machinery companies of this country. They said they were going down to the county seat of a certain county in Tennessee, where the road commissioners have \$18,000 to spend for road machinery. They do not know what they want, but we are going to tell them, and they will spend that \$18,000 on road machinery,—and they did it. The chances are that \$6,000 would have bought plenty of road machinery for that county. If that had been bought through an engineer, who would probably have been a competent man, he could have cut down their order for machinery and supplies to just what they needed and saved the county many thousands of dollars. Another illustration is in regard to a county in this State. One of our engineers became highway engineer for this county, and one of the conditions he insisted upon before accepting the position was that he must have supervision of the ordering of materials to be used on the road he had charge of. A certain bill of goods was about to be ordered by the commission, when the engineer insisted that, according to his agreement, he must go over it before the contract was let. When he got through revising it and showing them how to order, he had, if I remember correctly, saved from one-half to three-fourths of his yearly salary in that one order. Another illustration: A few days ago a certain county desired to buy a number of mules. They bought them without any reference at all to anybody who was familiar with purchasing mules for road work. It happened, if they had consulted an engineer, from whom they could easily have obtained advice, that they could have bought the same num-

ber of mules and a better quality of mules, at ten dollars per head less. They simply went ahead, placed their order, and bought a much lighter mule at a higher price, when they could have obtained a heavier mule at a lower price. That is why I insist that engineers must have supervision of the purchasing of supplies, and that no supplies shall be purchased by the commission except when the requisition for such supplies is made by the engineer. I want him to also go over the purchase before it is made to see that the estimated cost of those things is within reason. The engineer does know, and in most cases the commission does not, what these things ought to cost and what kind is needed. It applies to road machinery, road surfacing materials, culverts and bridges, and everything that is used in any way in road construction.

There is not a highway commission or board of county commissioners in North Carolina that knows anything about the technical side of the building of bridges, or, as a commission, know after a bridge is constructed whether or not it has been built according to specifications. In a certain county the commissioners in charge of the bridge work had been inserting small advertisements in the local county paper that upon such and such a date bids would be received for the erection of certain bridges. No one interested had seen these advertisements except one particular man within the county, and he had been getting all the bridge work in that county. Two contractors happened, by chance, to see one of these little advertisements; and decided it might be worth while to go down and enter bids, especially if there were two or more small bridges to be built. They investigated and found out what was wanted, and planned to put in bids of \$1,500 to \$1,800 for the bridges. Before entering their bids they heard of and met the contractor who had been getting all the bridge work in that county and knew he had been bidding on that same kind of work and getting the contract at \$3,300. They told him: "We do not want to spoil your plum down here." What was the result. The two agents divided a thousand dollars between themselves and let him have the bid. Now, if that commission had been obliged to submit all bridge work to an engineer that would not have happened. The bridge would have been bought at somewhere near its real value of \$1,500 instead of \$3,300. The time will come when not a single bridge will be built in North Carolina unless its design has been passed upon and its cost estimated by a competent engineer; and the commissioners will not be allowed to let a contract unless the price comes within the estimate of the engineer. This procedure will give the bridge companies a fair and square deal, and as soon as they know and realize this, it will be found that the cost of bridge building in North Carolina will drop very materially. I can give illustration after illustration of the extra cost of bridge work to the counties of North Carolina because this work has been done directly by the commission and the bridge companies and not through the engineer. I suppose I would be safe in saying that six- or eight-tenths of the bridge-letting in North Carolina is done directly by the commissioners upon plans and specifications submitted by the bridge companies themselves, and the commissioners seldom know whether the plans submitted by one company are anything like the plans submitted by another. They know nothing about bridge work, and are not expected to. I have seen specifications given out by commissioners for bridge work which were: we want a bridge so long, so wide, and not to cost over so much money. When the contract was let and the bridge built they were able to tell whether their specifications had been complied with; but whether it was the bridge that

was really needed they did not know. Every bridge should be passed upon by the engineer before the contract is let, and then, before the bridge is paid for, it should be approved by him as to whether or not it has been built according to contract.

In the original Highway Commission Bill was a section that no county in North Carolina should let a contract for a bridge until the plans and specifications for that bridge had been passed upon by one of the engineers of the Highway Commission, and that the bridge should not be paid for by the board until it had been inspected by the engineer and found to come up to specifications. We have several bridges in North Carolina which have supposedly been built according to plans and specifications, were guaranteed by the company and paid for by the county. One of our engineers was working in the county where one of these bridges had been built, and it was necessary for him to take a ten-ton roller across that particular bridge. This bridge had been guaranteed to carry just such a weight, and the county commissioners had paid for it with that understanding. This particular engineer was very sure the bridge would not hold up that weight. He went to the commissioners, and they said it would hold that weight and wrote the company, asking if they would guarantee the bridge to hold that roller, and they said, "No, put in certain girders before you take the roller across." Another case is a bridge in Randolph County. The commissioners accepted and paid for the bridge, and then had to spend \$600 more to bring the bridge up to what was needed and the specifications called for in the contract. The company made that extra \$600. I do not want you to get the idea that I believe all bridge companies are corrupt and are trying to do the counties and commissioners. They are not; some are simply taking advantage of existing conditions, and are perfectly willing to build any bridge that any county will accept as other companies are taking advantage of these conditions to do the counties. Now, if we have the plan of organization outlined above carried out, you will find we will be able to work out a standard design for certain bridges that will get much lower bids from bridge companies.

Some may think that I am advocating too much authority to the engineer in giving him absolute authority over the road work, but I do not think so. He can be removed by the road commission at any time, for cause. Public opinion is being moulded here in North Carolina to the extent that the people are beginning to realize and know that the highway engineer must have charge of the road work if it is to be successfully carried on. With public opinion behind such a policy it will seldom happen that county or township will undertake its roads without putting them under a competent highway engineer.

Public opinion is also going to insist that the State take a hand in this policy and pass laws making it obligatory upon commissioners to employ a competent highway engineer to have charge of all road work built by money raised by sale of bonds. We will find that just as soon as we get such an organization put into practice in this State we can show to the people that such an organization of engineers, superintendents and foremen gives the very best results in road work; that it makes the people's money go much further in road construction; and that they are getting a much better class of road than ever before.

A general bill has been passed by the General Assembly that where State convicts are worked on the public roads, their work must be done under the

supervision of the Highway Division of the Survey. Another bill was also passed that all State convicts, as soon as the prison contracts expire, shall be used on the public roads—given to the counties—and that they cannot work any road in any county that has not been located by a road engineer of the Survey, and the construction work must be done according to the plans and specifications of the engineers of the Survey and under their supervision.

A kick went up at the special session of 1913 in regard to that particular bill. The county said, "No, we want to be able to do as we please when we get the convicts there," but the amendment was voted down, and the work must be done under the supervision of the engineers of the Survey. So, North Carolina has committed herself to ask the General Assembly to adopt that general plan of organization which shows the relation of the engineer to the commission, which applies not only to the State, but to the counties.

DISCUSSION.

MR. FALLIS.—It is not always necessary to have all the various offices in separate men. For instance, the superintendent of roads might be purchasing agent, or one of the assistant engineers might be combined with him, and be made superintendent and purchasing agent, and occasionally the road engineer himself might, in case of small outfits, have control of all that. It depends upon the amount of work to be done in a county, and the size of the outfits to be used, as to how many of these various duties can be performed by one man. The combination of these duties in one man, and all such matters, should go through the road engineer in charge. The combination would, of course, be a matter of economy, and would also often be a matter of increased efficiency; thus one man would have more information at his hand, and thereby the advantage of not having to lose time to get in touch with other men, when so frequently time is of the greatest value. Then there is sometimes quite a little trouble where you have a purchasing agent whose whole duties are not in the road superintendent's office, and whose entire time is not given to the road work, as frequently purchases have to be made when the agent cannot be found.

Many of the details to be worked out should be left to the road engineer to make recommendations to the road commission, and his recommendations should always be followed, because he is the one responsible man, and is more interested in the success of the work in that county than any other one individual connected with the work. Building roads is his life work, by which he makes his living, and he has the same interest in the success of the work that the largest taxpayer or any citizen has in his own personal business, and he should be listened to and his advice followed exclusively so far as the work of organization and road construction is concerned.

Question. Should foremen of convict camps be combined with foremen of construction, as well as have charge of the care and keeping of the convicts?

There are certain combinations that can be made to work, but others that cannot. Guards should not be used in the dual position of guard and foreman of construction work. The man who has charge of the care of the convicts must be under the authority of the road engineer. If the superintendent also holds the position of road engineer, the convict camp must be indirectly under that man. The man who has complete charge of the road work must also have general charge of the convicts. This is because he is the one that is to be held responsible for getting the work out of the convicts, and as the ques-

tion of the discipline and punishment of the convicts must come before the engineer or superintendent, the ultimate authority must be vested in him.

The only way that the foreman of construction has to make the convict work is to report him to the superintendent of the camp. If the superintendent of the camp is not under the authority of the county engineer, he can treat that convict any way he wishes, and nine times out of ten the man or convict that causes trouble does so because he is punished by irresponsible parties. The organization should be such that the convicts on the road are under the county engineer from start to finish. The foremen handling the work directly should not be charged with the duty of caring for or disciplining the convicts.

MR. McALISTER. It is worth while to call attention to the fact that a road engineer who succeeds in delivering the goods is certainly the whole cheese in county work. It has been my limited experience that he has got to use mighty good judgment in delegating authority. Of course, usually the road engineer is really the general superintendent, but the road engineer should have absolute authority to the extent of hiring and discharging men under him. He should use his own discretion as to how much authority to hand down to the superintendent and sub-foreman as to hiring and discharging the men under them. You can get more work if that man knows he is under the "boss" in every way.

The purchasing agent is one of the most important men connected with the economical conduct of construction work. I know one city that bought enough apparatus last year to run any four cities in North Carolina. I will take anybody there and show him. They have spent four times as much as we have in Wilmington, because it was easy-come and easy-go. I think the man in charge of the work should have some say-so in it, because if he does not like that piece of equipment, he can either make it good or bad.

One thing I do not agree with you on, is putting the value of the equipment on the cost of the road. I think that ought to come in on a different head altogether. For this reason, if a county already had equipment it could be used without cost for that particular road.

While the road engineer is the head in regard to the supplies to be used, the road engineer will get the men together and go over with them in regard to the particular kind of machine, etc., they wish to use, etc., so that they can all work in close harmony.

MR. FALLIS. The importance of cost accounting in connection with purchasing agent should always be emphasized. If the cost accounting work is properly carried out, it will be found of great value in guiding the proper and wise purchase of supplies, and it is one, if not the greatest single item to guide the engineer in the economical expenditure of the county's money.

MR. HUGHES. I would like to present a motion that this Institute express by rising vote its appreciation and thanks to Dr. Pratt for making possible such an instructive and valuable Institute as this has been, and also to his associate and the Community Club for their genuine and much-enjoyed hospitality to all those attending the Institute.

Rising vote of appreciation.

Dr. Pratt called attention to Business Session and that three questions are open for general discussion:

How to Improve the Institute.

Correspondence Courses—Are They of Value?

Plan of Coöperation.

It shall be included in the Highway Commission Bill that there shall be held in each county each year a county road institute, under the supervision of one of the engineers of the State Highway Commission, which all county road officials, superintendents, supervisors, foremen, etc., are to attend. It shall be considered part of the official duties of the county road commissioners to attend such institute, and all cost and expenses of their attendance shall be borne by the counties. I believe that by getting together in this way we will get more than at a general institute here.

One thing in regard to improving the institute is this: Would it not be better to have a kind of recess of from fifteen to thirty minutes during the morning sessions of the institute, during which time the men could get together and talk over things?

Question: I want to ask you one thing: Have you an engineer in the State in actual construction work that is systematically going ahead with his work and picking out different materials that are available and sending them up here to you for your opinion?

Answer: No, we are not in a position to do actual testing now. If the Highway Commission Bill goes through, we will be able to get out such reports of road materials in a very reasonable time and not keep them for an indefinite time, as we have done in the past year. The United States Office of Public Roads has done a great deal of that work for us.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*
23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*
24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents.*
25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compositions Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D. *In press.*

ECONOMIC PAPERS.

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virginina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina. Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorjanite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Lox Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of western North Carolina are described, giving distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. *The Mining Industry in North Carolina During 1907*, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. *Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina*, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. *Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908*. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. *Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909*, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. *Forest Fires in North Carolina During 1909*, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. *Wood-using Industries of North Carolina*, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. *Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified)*. Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. *Forest Fires in North Carolina During 1910*, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. *Mining Industry in North Carolina During 1908, '09, and '10*, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. *Fishing Industry of North Carolina*, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. *Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation*. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. *Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911*, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. *Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911* by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. *Culverts and Small Bridges for Country Roads in North Carolina*, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. *Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911*, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. *Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey*. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; The new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley, 1915. 8°, ... pp., 30 pl., 262 figs., 1 map. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Olam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Out-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of

Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Ruda, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the U. S. Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the U. S. Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that **NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE.** Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

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DEPT. OF
HIGHWAY
CONSTRUCTION

THE NORTH CAROLINA HIGHWAY CONSTRUCTION BOARD

CONSTRUCTION DIVISION

REPORT NO. 101

ROADWORK IN NORTH CAROLINA

REPORT NO. 101

1934

STATISTICAL SECTION

THE NORTH CAROLINA HIGHWAY CONSTRUCTION BOARD

CONSTRUCTION DIVISION



1934

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 44

HIGHWAY WORK IN NORTH CAROLINA

**DURING THE CALENDAR YEAR ENDING
DECEMBER 31, 1914**

A STATISTICAL REPORT

COMPILED BY

JOSEPH HYDE PRATT, State Geologist

AND

MISS H. M. BERRY, Secretary



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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., May 1, 1916.

*To His Excellency, HON. LOCKE CRAIG,
Governor of North Carolina.*

SIR:—The North Carolina Geological and Economic Survey, in coöperation with the United States Office of Public Roads, has collected data for the calendar year 1914 in regard to road work in the State, including mileage, finances, administration, maintenance, uses of convict and free labor, etc. The results of these statistics throw considerable light on the road situation in the State, and it is believed that their publication from year to year will help the people of the State to realize, more than anything else, the inefficiency of present methods of road work and administration, and the necessity for the inauguration of more effective and scientific methods. I am, therefore, submitting these statistics in the form of a report, to be published as Economic Paper No. 44 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

3. Geol. & Econ. Survey 12-6-17g

HIGHWAY WORK IN NORTH CAROLINA

DURING THE CALENDAR YEAR ENDING DECEMBER 31, 1914

COMPILED BY

JOSEPH HYDE PRATT, STATE GEOLOGIST, AND MISS H. M. BERRY, SECRETARY.

The present report covers an investigation, conducted by the North Carolina Geological and Economic Survey in coöperation with the United States Office of Public Roads, in regard to road mileage, road funds, whether by taxation, bond issue, labor tax, etc.; convict labor on public roads; administrative boards; and systems of maintenance. The statistics given in this report apply to the calendar year ending December 31, 1914, and consist, in the main, of tables, accompanied by a brief explanatory text.

GENERAL STATEMENT REGARDING NORTH CAROLINA AND HER ORGANIZATION AS TO ROAD ADMINISTRATION.

North Carolina has an area of 52,286 square miles, which includes a land area of 48,666 square miles and a water area of 3,620 square miles. Its extreme length from east to west is 503 1-4 miles, and extreme width from north to south is 187 1-2 miles. It is bounded on the north by the State of Virginia, on the east by the Atlantic Ocean, on the south by the States of South Carolina and Georgia, and on the west by the State of Tennessee. It has one hundred counties, varying in size from Robeson, with the largest land area, amounting to 870 square miles, to New Hanover, the smallest, with an area of 162 square miles. Extending from the coast westward to the mountains for a distance of over 500 miles, it includes within its boundaries every variation in topography, from the lowlands of the coastal plain region and the higher region of the piedmont plateau to the steep mountain regions of Western North Carolina. Similar variations are to be found in its climate and geological formations.

All these diverse conditions make the highway problems of the various counties of the State exceedingly complex, and each section has its own problems with regard to location, drainage, surfacing materials, and maintenance. Thus, according to the section of the State in which the county is located, it is found advisable to use macadam, gravel, sand-clay, or topsoil as surfacing materials. Nature

has, however, been very generous in supplying rather abundantly suitable materials for making sand-clay* roads, and because North Carolina is essentially a rural State, containing but few large cities, the sand-clay road for the most part meets traffic conditions over a very wide section. The State is exceedingly well watered, and the problem of culvert and bridge construction and repair is a vital one. All the road work in North Carolina is under the direction of local county or township officials. Up to the last two or three years all assessments were made by county commissioners and the accruing funds spent under their direction. Within the past two or three years, however, especially where bonds have been voted for building public roads, special road commissions have been appointed, either for the entire county (when county bonds have been issued) or for townships or road districts, as the case may be; so that during 1914 the road funds of the State were administered by county commissioners, county road commissioners, township road commissioners or trustees, etc.

The modern movement for better roads in North Carolina may be said to have begun in 1879, when the General Assembly passed what is known as the Mecklenburg Road Law. This was proposed as a general State law, but when passed it applied to only three counties—Mecklenburg, Forsyth, and Stokes. It provided for the working of public roads partly by taxation and partly by the old labor system; but even in this moderate form it was ahead of its time, and in 1881 was repealed. Up to the passage of this law all the road work had been done by the free-labor system, which is still in vogue in a number of counties, in some still being the only system in use, and in others supplemented by a road tax or bond issue. This Mecklenburg law, which was reenacted, can be adopted as the road law of any county by a vote of the county commissioners on petition signed by a number of freeholders in the county.

The General Assembly of 1913 passed a great many acts relating to the issuing of road bonds by counties and townships. There was a great lack of uniformity in these bills and wide variation in the method of issuing the bonds, some being authorized by election on a set date; some by election on petition to county commissioners, others to be issued directly by the county commissioners without vote or petition, and still others to be issued in the discretion of the county commissioners. Some of the acts called for special road or highway commissions to take charge of the road work and others placed the road work under the township commissioners and county commissioners.

There was one law of a general nature passed authorizing any township (except in the counties of Rockingham, Madison, Anson, and

*Sand-clay includes gravel and topsoil.

Robeson) to vote upon bonds, not exceeding \$50,000, upon petition to boards of county commissioners. Elections for these bond issues are to be called by said board upon petition of one-fourth of the qualified voters of any township.

STATE ROAD WORK.

Up to the present time no work has been done directly under the State, except such educational work and engineering assistance as could be rendered by the small appropriation of \$5,000 a year allotted to the highway department of the North Carolina Geological and Economic Survey. Certain special work, however, was allotted to this department by the Legislature of 1913, as the supervision of the construction of the Hickory Nut Gap Road (a link of the Charlotte-Asheville Highway), which is being built by State convicts, and similar supervision of a link of the Central Highway in Madison County. State convicts were also allotted to do this work.

SOURCES OF INFORMATION.

The facts given in this report were obtained from chairmen of boards of county commissioners, chairman of road commissions (both county and township), from registers of deeds, clerks of courts, road engineers, road superintendents, and in some cases from private individuals. The county and road commissions were first written to and given an opportunity to fill out the list of questions. A second request was sent with a personal letter. In many instances third, fourth, and fifth requests were mailed to such parties as it was thought could give reliable answers. In a few cases personal visits were made by engineers of the Geological Survey to road officials and the desired information secured.

In compiling the special-tax figures, access was had to the report of the State Auditor, and we were able to compute the amount of special tax from this, thus checking up these returns. This office keeps in touch with the bond issues which are being voted from time to time by different counties and townships, and thus we were able to check this data with the reports sent in.

As to mileage in the counties, these figures were adjusted with figures which had been received in previous years for total mileage, and the figures for improved mileage were checked by considering average cost per mile with available funds.

While all data given may not be absolutely correct, it is believed that it is as nearly correct as can be had from any available sources

of information. None of the counties or townships in which road work is being done keep accurate cost data, and practically none of the counties have had road maps made of them, so that, while the figures given as to mileage cannot be taken as absolutely correct, yet they are close approximations.

TABLE I

Revenue by Counties and Townships from Direct Taxation (Property and Poll), Special Taxes (Auto Tax, Dog Tax, Central Highway Tax), Labor Tax, and Private Subscription.

It will be noted from this table that in some instances there is a tax levied for the entire county for road improvement, in other instances townships have a special levy for road building, while in still other cases there is a county levy supplemented by additional levies in certain townships.

In column 1 is given the rate for county levies per \$100 worth of property.

In column 2 is given the rate of township levies per \$100 worth of property.

In column 3 is given the rate on polls by counties.

In column 4 is given the rate by townships on the poll.

Column 5 gives the amounts obtained from both property and poll taxes in counties and townships.

Column 6 gives the purposes for which these taxes are levied, as for repair and maintenance of dirt roads; construction of new roads; interest and sinking fund on bond issues; bridges, etc.

Column 7 gives the allotment by counties of the State automobile tax. This tax is supposed to be used for the upkeep of roads, but is sometimes diverted from that purpose.

Column 8 specifies certain other sources of revenue, as private subscriptions; dog taxes; value of labor contributions; tax for Central Highway; Federal funds; excess fees of county officers used for roads; United States Department of Agriculture fund; sale of railroad stock; money borrowed by county commissioners for roads; railroad tax; and chain-gang tax.

Column 9 gives the amounts raised from the sources designated in column 8.

Column 10 gives the total amount for road purposes derived from columns 5, 7 and 9.

Column 11 gives by counties and townships the number of days of free labor required from citizens in rural districts.

Column 12 gives the age limits of citizens who are subject to this labor tax.

Column 13 gives by counties and townships the estimated number of men who are subject to this labor tax.

TABLE I. REVENUE FOR ROAD WORK IN NORTH CAROLINA—BY SPECIAL TAXES.

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Alamance		\$0.16 $\frac{1}{2}$		\$		\$ 17,629.98	Const. and repr...
Alexander		0		0			Repair
	Ellendale		.25		.75	*1,000.00	
Alleghany		0		0			Repair
Anson		25-30		75-90c		19,683.00	Constr.
Ashe							Repair
Avery		.20		0		4,500.00	Repr. dirt roads
Beaufort							Const. and repr...
	Chocowinity						
	Long Acre		.10		2.00	8,256.03	
	Richland						
	Washington						
Bertie		.20 $\frac{1}{2}$		0		13,724.78	Bridges and repr. dirt roads
Bladen		.10		.30		6,000.00	Repair
Brunswick		.25				1,000.00	
	Lockwood's Folly						
	Northwest						
	Shallotte		.12		.36	4,500.00	Int. and sink. fund
	Smithfield						
	Town Creek						
Buncombe		.20		0		51,128.78	Const. and repr...
	Black Mountain	.20				1,800.00	
Burke		.20		0		8,759.44	Const. and repr...
	Morganton						
	Silver Creek		.08 $\frac{1}{2}$			2,300.00	Int. and sink. fund
Cabarrus		.30		0		30,280.00	Const. and repr...
Caldwell		0		0			
	Lovelady						
Camden		0					
Carteret		.15		0		5,460.00	Int. and sink. fund const. and repr.
Caswell		.10		0		3,000.00	
Catawba		.20		0		*12,371.00	Repr. and bridges
	Hickory		.20	0		7,242.65	Int. and sink. fund
	Newton		.30			*4,500.00	Int. and sink. fund
Chatham		.10		0		6,836.76	Repr. dirt road
Cherokee		.10		0		*5,000.00	
	Marble Dist.		.21 $\frac{1}{2}$			*2,000.00	
	Murphy		.55			11,000.00	Int. and sink. fund
	Valley Town		.35		1.05	6,500.00	
Chowan		0					
	First		.07 $\frac{1}{2}$		.22 $\frac{1}{2}$		
	Second		.20		.60		
	Third		.20		.60	5,300.00	Repair
	Fourth		.20		.60		
Clay		.10		0		1,109.00	Repair

*Estimated.

GIFTS, LABOR, AND ALL OTHER SOURCES EXCEPT BOND ISSUES DURING 1914.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 1,004.00	Priv. sub.....	\$ 400.00	\$ 19,033.98	3 days or \$1.25	21-45	2,000
131.60			131.60	6	18-45	1,500
			1,000.00			
1.60	Priv. sub.....	500.00	501.60	6 const., 8 repr.	18-50	700
494.40	{ Priv. sub.....	1,000.00	23,677.40	6	18-45	2,000
	{ Labor, etc.....	2,500.00				
20.00			20.00	8	18-45	1,000
8.00			4,508.00			0
903.00			903.00	3	18-45	1,200
			8,256.03			
856.20			14,580.98	4	18-45	3,000
125.60	Priv. sub.....	500.00	6,625.60			0
100.40			1,100.40	6	18-45	1,000
			4,500.00			0
3,495.40	Priv. sub.....	5,000.00	59,624.16	4 days or \$3.00	21-45	2,835
			1,800.00			0
316.20			9,075.64	6	18-45	1,200
			2,300.00			0
1,100.60	{ Labor.....	200.00	32,080.60	0		0
	{ Priv. sub.....	500.00				
439.40	{ Labor.....	400.00	2,639.40	6	18-45	3,000
	{ Priv. sub.....	1,800.00				
						0
60.00			60.00	6	18-45	1,000
127.60	Labor.....	200.00	5,787.60	6	18-45	800
312.80	{ Dog tax.....	1,800.00	5,412.80	4	18-45	1,500
	{ Priv. sub.....	300.00				
1,100.40	Priv. sub.....	2,000.00	15,471.40			0
			7,242.65			0
			*4,500.00			0
284.80	{ Corp. tax.....	1,103.00	10,124.56	3	21-45	3,000
	{ Dog tax.....	1,100.00				
	{ Priv. sub.....	800.00				
105.60	Labor.....	500.00	5,605.60	8	21-45	1,400
			2,000.00			
			11,000.00	6	21-45	600
			6,500.00			
431.80	Priv. sub.....	100.00	531.80			0
			5,300.00			0
4.00			1,113.00	4	18-45	300

TABLE I

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Cleveland.....		\$.25	\$.00	\$.00	\$.00	\$.00	
	No. 2.....					*23,000.00	Int.. sinking fund and repair.....
	No. 4.....						
	No. 6.....						
	No. 7.....						
	No. 8.....						
	No. 9.....						
Columbus.....		.10		0		11,266.80	Constr. and repr.. and brdg. matr..
Craven.....	Levied by Township..	.20		.60		25,344.40	Const. and repr..
Cumberland.....		.25		0		26,000.00	Const. and repr.. and bridges.....
Currituck.....		0		0			
Dare.....		0		0			
Davidson.....	Levied by Township..	15-20		45-60		21,880.00	Repr. dirt roads ..
Davie.....		.20		.60		10,059.33	Int. sinking fund and repair.....
Duplin.....		0					Repr. dirt roads..
	Calypso.....						
	Cypress Creek.....						
	Faison.....						
	Island Creek.....		.20			*2,000.00	
	Rose Hill.....						Int. on bonds.....
	Wallace.....						
	Warsaw.....		.20	.60		*1,500.00	Int. on bonds.....
Durham.....		.17		0		47,928.04	Const. and repr. and bridges.....
Edgecombe.....		.25				19,082.15	Const. and repr..
	Whitakers R. D.....		.23				
	Rocky Mount R. D.....		.20	.60		11,119.38	Const. and repr.
Forsyth.....		.28		0		82,728.64	Const. and repr. and bridges.....
Franklin.....		.10				6,482.00	
	Franklinton.....		.35	1.05		6,800.00	
	Louisburg.....		.25	.75		4,500.00	
	Youngsville.....		.30	.90		2,600.00	
Gaston.....		.25		.75		41,250.00	Const. and repr. bridges.....
Gates.....		0		0			Rpr. dirt roads ..
	Holly Grove.....		.20	.60		1,318.88	Int. on bonds.....
Graham.....		.25				1,233.00	Repr. dirt roads ..
	Cheoah.....		.30	.90		2,700.00	Repr. dirt roads ..
	Stecoah.....		.30	.90		1,200.00	Repr. dirt roads ..
Granville.....		.30				28,405.77	Const. and repr..
Greene.....	By Townships.....	.59				10,661.26	Int. sinking fund and repairs.....
Guilford.....		.23				70,000.00	All purposes, including bridges ..
Halifax.....	By Townships.....	.25		2.00		32,000.00	Int. sinking fund and repairs.....

*Estimated.

†For three townships.

‡Sandy Creek Township.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 852.20		\$	\$ 852.20			0
			23,000.00			0
505.60	{ Spec. tax.....	603.00	13,775.40	6 days or \$3.00	21-45	4,000
	{ Priv. sub.....	1,200.00				
	{ Wk. civic week ..	200.00				
1,135.00	Tax for Cen. Hwy.	3,100.00	29,579.40	0		0
872.00		0	26,872.00	0	0	0
143.60			143.60	3-6	18-45	1,000
61.60		0	61.60	6	18-45	500
1,337.00			23,217.00	16	18-45	1,000
223.80	Fed. funds.....	12,425.00	22,708.13	0	0	0
304.40			304.40	6	18-45	3,000
	Priv. sub.....	1,800.00	1,800.00			
			2,000.00			
			1,500.00			
1,622.80	Dog tax.....	572.50	50,123.34	0	0	0
1,680.60			20,762.75	0	0	0
			11,119.38			
2,699.80	{ Priv. sub.....	1,550.00	88,390.69	0	0	0
	{ Fed. funds.....	1,412.25				
725.20	Priv. sub.....	150.00	7,257.20	6	21-49	1,000
			6,800.00			
			4,500.00			
			2,600.00			
1,257.00	Priv. sub.....	1,250.00	43,757.00	0	0	0
127.20	Labor given.....	350.00	477.20	0	0	0
			1,318.88			
			1,233.00	4	18-45	700
			2,700.00			
			1,200.00			
854.00	Dog tax.....	984.50	30,244.27	4	21-45	3,000
444.00			11,105.26	6	18-45	2,000
4,708.00	{ Excess fees coun-ty officers.....	14,000.00	89,708.00	0	0	0
	{ Priv. sub.....	1,000.00				
1,424.60	Priv. sub.....	500.00	33,924.60	0	0	0

TABLE I—

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Harnett.....		\$.....	\$.....	\$.....	\$.....	\$.....	Int. and Const.....
	Hectors Creek.....						
	Lillington.....		.20		.60	5,000.00	
	Upper Little River..						
Haywood.....		.12				6,444.00	Genl. purposes.....
	Waynesville.....		.33½			7,287.00	
Henderson.....	By Townships.....	.20				9,000.00	Int., sink. fund, repairs and brgs.
Hertford.....		0					
	Ahoskie.....		.25		.75	2,636.00	Gen. repr. drt. rds.
	Harrellsville.....		.25		.75	2,053.00	Gen. repr. drt. rds.
	Maney's Neck.....		.25		.75	1,821.00	Gen. repr. drt. rds.
	Murfreesboro.....		.05		.15	378.00	Gen. repr. drt. rds.
	St. Johns.....		.30		.90	3,117.00	Gen. repr. drt. rds.
	Winton.....		.25		.75	2,698.00	Gen. repr. drt. rds.
Hoke.....		.25		.75		7,500.00	Int. and reprs.....
Hyde.....		0					
	Fairfield.....		.20		.60	696.85	Bridges and repair dirt roads.....
	Swan Quarter.....		.20		.60	856.84	
Iredell.....		.25		.75		36,221.23	Int. sinking fund, reprs. and brgs..
Jackson.....							
	Cullowhee.....						
	Dillsboro.....		10-55		30-1.65	9,118.00	Int. and sinking fund
	Sylva.....						
Johnston.....	By Townships.....	.25				28,874.24	Const. and rpr....
Jones.....		.20		.60		6,308.79	Repr. dirt roads and grading....
Lee.....		.17½		.60		8,655.00	Int. sinking fund, repr. and brdgs..
Lenoir.....		.18		0		14,287.72	Const., rprs. and bridges.....
Lincoln.....		.20		.60		*12,000.00	Int., sinking fund and repairs.....
Macon.....		.34				8,150.48	Repr. dirt roads ..
McDowell.....	Franklin.....	.10				1,500.00	Repr. dirt roads ..
	Marion.....		.30			5,563.39	Int. and skg. fund
	Nebo.....		.20			*1,200.00	Int. and skg. fund
	Old Fort.....		.25			3,500.00	Int. and skg. fund
Madison.....		.30		0		10,916.70	Int. and skg. fund
Martin.....							
	Robersonville.....		.16½		.50	2,600.00	Int. and skg. fund
	Williamston.....		.50		1.50	7,019.13	Const. and rpr....
Mecklenburg...		.30					
	All Townships.....		.10			130,720.00	30c const., 10c rpr., const. and rprs..
	Berryhill.....		.12½				
Mitchell.....		.50		0		11,000.00	Repr. dirt roads and bridges.....

*Estimated.

†Harp's Road.

‡In three townships.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 698.40	{ Dog tax..... Priv. sub..... Priv. sub.....	{ \$ 200.00 300.00 13,500.00	{ \$ 1,198.40 8,500.00	6	18-45	1,500
243.20	{ Priv. sub..... Spec. tax.....	{ 400.00 4,000.00	{ 11,037.20 7,287.00	6	18-45	3,000
584.40	Priv. sub.....	1,000.00	10,584.40	5 days or \$2.50	21-45	600
446.00			446.00	6 days or \$3.00	18-45	2,500
			2,636.00			
			2,053.00			
			1,821.00			
			378.00			
			3,117.00			
			2,698.00			
469.20			7,989.20	0	0	0
185.60			185.60	16	18-45	500
			696.85			
			856.84			
1,377.40	U. S. Dept. Agri- culture Fund	3,802.88	41,401.51	0	0	0
16.00			16.00	4	18-45	2,000
			9,118.00			
1,475.00	Priv. sub.....	1,000.00	36,349.24	6 days in 8 twps.	21-45	1,800
170.00	{ Labor sub..... Labor sub.....	{ 300.00 700.00	7,478.79	2 days or \$1.00	21-45	1,000
296.60			8,951.60	0	0	0
1,044.40	{ Priv. sub..... Sale R. R. stock.....	{ 1,500.00 37,500.00	54,332.12	0	0	0
449.20			12,449.20	0	0	0
55.60	{ Priv. sub..... Labor.....	{ 200.00 50.00	8,456.08	4 days or \$2.00	18-45	1,500
105.20			1,605.20	6	18-45	1,000
			5,563.39	4	18-45	600
	Priv. sub.....	62.00	1,282.00	5	21-45	500
			3,500.00	5	21-45	250
6.00	Fed. Fund.....	10,000.00	10,922.70	6 days or \$5.00	18-45	1,500
812.60			812.60	6	21-45	1,700
			2,600.00			
	Spec. tax.....	234.90	7,254.03			
4,699.40			135,419.40	4	21-45	2,000
				2	21-45	
0			11,000.00	4	21-45	1,100

TABLE I—

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Montgomery		\$.10	\$.	\$.	\$.	\$ 12,624.73	Const. and rpr....
Moore	Uwharrie		.30			4,303.16	Const. and rpr....
	Bensalem						
	Carthage						
	Deep River						
	Greenwood		.25		.75	*19,000.00	Const. and rpr....
	McNeills						
	Mineral Springs						
	Sand Hills						
Nash	Road Districts						Int. and skg. fund
	Baileys		.30		.90		
	Castalia		.30		0		
	Coopers Creek		.30		0		
	Dry Wells		.30		0		
	Ferrells		.30		.90		
	Griffin		.30		0	*40,000.00	
	Jacksons		.30		0		
	Mannings		.30		.90		
	Red Oaks		.30		0		
	Rocky Mount		.20		.60		
	South Whitakers		.30		0		
New Hanover		0		0		*75,000.00	
Northampton		.20					Const. and rpr....
	Rich Square			1.50		16,308.20	Int. and skg. fund
Onslow		0					Repr. dirt road and bridge
	Jacksonville		.20		.60	3,638.20	
Orange		.35		0		18,780.00	Int. sinking fund and repr....
Pamlico		.20		0		3,579.00	Repr. road and bridges
Pasquotank		.13		0		9,720.27	Rpr. roads and bridges
Pender		0		0			Repr. dirt roads and bridges
	Rocky Point		.20		.60	1,200.00	Repr. dirt road
Perquimans		.35		1.05		13,351.41	Repr. dirt road
Person		.25		0		11,613.00	Repr. dirt road
Pitt		.15		.45		15,000.00	Bridgs. and general road work
	Greenville		.30		0	3,500.00	Int. sinking fund and repair
Polk		.52		0		10,010.00	Bridgs. int. sinkg. fund and rpr....
Randolph		.08½		0		6,500.00	Bridges, const., repair
Richmond		.33½		1.00		29,333.00	Const. and rprs...
Robeson		.21		0		36,521.18	Rpr. dirt roads
Rockingham		.24		0		28,000.00	Const. and rpr....
Rowan		.35		1.05		51,256.00	Const., rpr., and bridges
Rutherford		.15		2.00		16,050.81	Int. sinking fund, const. and rpr...

*Estimated.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 482.00	{ Labor..... Priv. sub.....	{ \$1,000.00 4,200.00 }	\$18,306.73	4 days or \$4.00	18-45	2,000
1,144.20			4,303.16			
			1,144.20	0	0	0
	Priv. sub.....	500.00				
	Priv. sub.....	200.00	21,700.00			
	Priv. sub.....	2,000.00				
1,452.60			1,452.60			
			40,000.00			
2,449.60			77,449.60	0	0	0
532.60			532.60	3	21-45	2,700
			16,338.20			
162.00	{ Labor..... Priv. Sub.....	{ 500.00 250.00 }	912.00	4	18-45	1,200
			3,638.20			
441.20	{ Priv. sub..... Dog tax.....	{ 250.00 700.00 }	20,171.20	0	0	0
80.00	{ Labor..... Spec. Tax.....	{ 50.00 175.00 }	3,884.00	4	21-50	1,360
699.80			10,420.07	0	0	0
182.00	Labor.....	6,000.00	6,182.00	8	18-45	1,400
			1,200.00			
238.00			13,589.41	0	0	0
502.40	Labor.....	400.00	12,515.40	0	0	0
2,033.40	Priv. sub.....	500.00	17,533.40	5	18-45	2,000
	Priv. sub.....	3,500.00	7,000.00			
90.00			10,100.00	4	21-45	1,000
749.80	{ Borrowed by Co. Priv. sub.....	{ 26,000.00 30,000.00 }	63,249.80	4	18-45	3,600
1,169.40	{ Labor..... Priv. sub.....	{ 1,000.00 500.00 }	32,002.40	0	0	0
1,437.80			37,958.98	4 days or \$2.00	21-50	7,360
1,053.60			29,053.60	2 days or \$1.00	21-45	2,960
1,986.40	Labor and haul- ing.....	1,500.00	54,742.40	0	0	0
703.20	Priv. sub.....	200.00	16,954.01	0	0	0

TABLE I—

County	Township	Rate on Property		Rate on Poll		Total Amounts Obtained from Property and Poll Taxes	For What Used
		County	Township	County	Township		
Sampeon.....		\$.12	\$.---	\$ 0	\$.---	\$ 10,000.00	Int. on bonds and bridges.....
Scotland.....		.20	---	0	---	6,993.00	Rpr. dirt road....
	Laurel Hill.....		.33†		0	*1,500.00	Int. sinking fund and repair.....
	Spring Hill.....		.50†		0	*2,500.00	Int. sinking fund and repair.....
	Stewartsville.....		.30		0	*8,500.00	Int. sinking fund and repair.....
	Williamson.....		.45		0	*4,500.00	Int. sinking fund and repairs.....
Stanly.....		.10	---	0	---	5,631.00	Bridges, grading and repair.....
	N. and S. Albemarle ..		.25		.75	7,450.00	Grading and rprs..
Stokes.....			---		---	---	---
	Danbury.....		.40		1.20	---	---
	Meadows.....		.30		1.05	*20,000.00	Int. sinking fund and repair.....
	Sauratown.....		.40		1.20	---	---
Surry.....		0	---	---	---	---	Int. sinking fund..
	Mount Airy.....		.20		.60	6,600.00	Repr. dirt road ...
Swain.....		.10	---	0	---	2,784.70	Const. and rpr....
Transylvania ..	By Townships.....	0	15-25c	.45	---	6,073.40	---
Tyrrell.....		0	---	---	---	---	Repr. dirt road ...
	Scuppernong.....		.15		---	367.00	Constr. and rpr....
Union.....		.25	---	---	---	11,066.00	Constr. and rpr....
	Monroe.....		.14		.75	10,387.55	---
Vance.....		.17	---	.51	---	16,661.55	Int. sinking fund and repair.....
Wake.....		.25	---	---	---	70,749.41	Repr. and const., gen. road work and bridges.....
	Cary.....		---	---	---	---	---
	Cedar Fork.....		---	---	---	---	---
	Holly Springs.....		†.10		---	3,812.66	Rpr. and const....
	Middle Creek.....		---	---	---	---	---
	Panther Branch.....		---	---	---	---	---
Warren.....		.25	---	---	---	8,685.00	Repr. and brdgs..
	Warrenton.....		.25		.75	3,750.00	Int. and snk. fund
Washington.....		.20	---	.60	---	10,000.00	Constr. and rpr....
Watauga.....		.21†	---	---	---	5,550.30	Constr. and rpr....
Wayne.....	By townships.....		.10		.30	13,757.00	Rpr. dirt roads ...
	Goldsboro.....		.20		.60	9,000.00	Constr. and rpr....
Wilkes.....		.10	---	0	---	6,292.00	Rpr. dirt roads ...
Wilson.....		.25	---	.75	---	32,284.00	Repr., constr. and bridges.....
	Toisnot.....		.30		.90	*5,000.00	Rpr., constr. and bridges.....
Yadkin.....		---	---	.40	---	5,135.20	Repair.....
Yancey.....		.15	---	---	---	2,811.00	Repair.....
Totals.....						\$1,782,193.15	

*Estimated.

†Extra.

Continued.

Amount of Auto Tax	Other Sources		Totals from All Sources	Average Number of Days Worked Per Man	Age Limit	Estimated Number Men Subject to Labor Tax
	How Derived	Amount				
\$ 493.60	{ Dog tax.....	\$ 2,500.00	\$ 14,493.60	6	18-45	3,000
1,100.80	{ Priv. sub.....	1,500.00				
			8,093.80	0	0	0
			*1,500.00			
			*2,500.00			
			*3,500.00			
			*4,500.00			
702.60			6,333.60	4	21-45	1,000
			7,450.00			
216.80			216.80	6	18-45	2,000
			20,200.00			
526.00	R. R. tax.....	200.00	1,126.00	6	18-45	2,000
	Priv. sub.....	600.00	6,600.00			
20.00			2,804.70	4	18-45	1,500
216.60	Chain-gang tax					
	10 cents.....	2,536.70	8,826.70	4 days or \$4.00	18-45	1,500
128.40			128.40	6	21-45	1,500
	Priv. sub.....	17.00	384.00			
612.20	Priv. sub.....	200.00	11,878.20	6	18-45	3,500
			10,387.55			
1,044.00	Priv. sub.....	600.00	18,305.55	0	0	0
3,519.40	Dog tax.....	3,643.00	77,911.81	0	0	0
			3,812.66			
619.00			9,304.60	0	0	0
			3,750.00			
398.40			10,398.40	6 days or \$2.00	21-45	500
5.60			5,601.90	4 N. R., 8 O. R.	18-45	1,500
1,542.00			15,299.00	6	18-45	2,800
	Cent. Hway. tax	500.00	9,500.00			
149.40	{ Labor.....	3,000.00	9,641.40	10	18-45	3,000
	{ Priv. sub.....	200.00				
1,590.40			33,874.40	0	0	0
			*5,000.00			
107.60			5,212.80	6	18-45	1,500
8.00			2,819.00	6	18-45	3,000
\$76,173.40		\$221,271.73	\$2,105,238.28			121,225

A review of this table shows that seventy-six counties have levied a special tax for road work, the tax being levied for the whole county. The greater proportion of this was spent, in connection with the labor tax, in the repair of the dirt roads of the counties. As a rule, this money is not spent under the direction of a competent road engineer or superintendent, but is apportioned among the townships and used to employ people, unskilled in road building, who live along the road, to work at such times as their crops are not needing them. Thirty-seven counties have from one to twelve townships levying special road tax. There were seventeen counties which had a county road tax, supplemented by special township taxes. Twenty counties had a poll tax for roads and forty-six townships in twenty-eight counties reported a similar tax. Twelve counties reported other special taxes used for road work, such as dog tax, railroad tax, Central Highway tax, chain-gang tax, etc., aggregating \$37,717.70 in 1914; \$76,173.40 from the State automobile tax was reported to have been returned to the counties to be used on the roads. During 1914, \$92,279 were used in forty-eight counties from private subscriptions of money, labor, and teams. One county sold railroad stock to the amount of \$37,500, which was spent on the public roads during 1914, and three counties were aided by the expenditure of Federal funds. This makes a total of \$2,105,238.28 which was reported to have been spent on the public roads during 1914 from taxes of various kinds, private subscriptions, Federal funds, etc. Of this amount, it was reported that \$312,300 was spent for interest and sinking funds on bond issues; and it was estimated that \$674,577.28 was used for maintenance or upkeep of the public roads, \$125,000 for construction and repair of bridges, and \$316,628 for the construction of new roads.

In addition to the above taxes, sixty-seven counties have a labor tax, and these reported during 1914 an aggregate of 121,225 men subject to this tax who worked on an average 5.17 days each during the year, making a total of 676,733 1-4 days of labor put on the roads in these counties during 1914. Valuing this labor tax at \$1 per day, this makes an additional \$676,733.25 spent on the roads during 1914.

TABLE II

County and Township Expenditures for Roads by Bond Issues

This table gives revenue from bond issues. These bonds are issued either as county bonds or township bonds, and frequently county bonds are supplemented by special bond issues in certain of its townships.

Column 1 gives the total amount of bonds by counties and townships issued to January 1, 1913.

Column 2 gives date of sale of these bonds.

Column 3 gives amount of bonds voted during 1913.

Column 4 gives amount of bonds sold during 1913.

Column 5 gives amount of bonds voted during 1914.

Column 6 gives amount of bonds sold during 1914.

Column 7 gives total amount of bonds issued to January 1, 1915.

HIGHWAY WORK IN NORTH CAROLINA

TABLE II. REVENUE BY BOND ISSUES.

County	Township or District	Bonds Issued to January 1, 1913	Date of Sale	Bonds Voted During 1913	Bonds Sold During 1913	Bonds Voted During 1914	Bonds Sold During 1914	Total Amount of Bonds Issued to January 1, 1915
Alamance.....		\$ 200,000.00	1908	\$.....	\$.....	\$.....	\$.....	\$ 200,000.00
Alexander.....								
Alleghany.....								
Anson.....	Township.....	50,000						50,000
Ashe.....	Wadesboro.....	50,000	1912					50,000
Beaufort.....	Horse Creek.....			5,800	5,800			5,800
Bertie.....		20,000	1911	50,000	25,000		25,000	50,000
Bladen.....	Township.....	5,000	1907					20,000
								5,000
	Brown Marsh.....			10,000				10,000
	Carver's Creek.....	10,000	1908		10,000	5-1-'14	10,000	20,000
Brunswick.....	Lockwood's Folly.....	10,000	1911					10,000
	Northwest.....		Jan. 1915 confd			15,000	15,000	15,000
	Shallotte.....	10,000	1908					10,000
	Smithville.....			30,000				10,000
	Town Creek.....	15,000	1911			10,000	10,000	25,000
Buncombe.....		275,000		50,000	50,000	75,000	75,000	400,000
	Black Mountain.....	20,000	1907					20,000
Burke.....								
	Morganton.....			50,000	20,000		15,000	50,000
Cabarrus.....		105,000		50,000	50,000			*155,000
Caldwell.....								
Carteret.....	Lovelady.....					25,000		25,000
	Morehead.....			10,000			10,000	10,000
	Newport.....			3,000	3,000	5,000	5,000	8,000

Catawba—	Hickory.....	50,000	1912						50,000
	Newton.....	50,000	1912						50,000
Chatham—	Haw River.....							20,000	20,000
Cherokee—	Marble District.....	68,000							68,000
	Murphy Township.....	180,000							180,000
	Valley Town Twp.....	47,000	1907 and 1911						47,000
Cleveland—	No. 3.....			50,000					50,000
	No. 4 (Kings Mountain)	125,000	1910					25,000	150,000
	No. 6 (Shelby).....	50,000	1911-12					60,000	110,000
	No. 7.....			50,000					60,000
	No. 8.....			50,000				50,000	100,000
Davidson—	Lexington.....	100,000							100,000
Davie—				175,000		140,000			175,000
Duplin—	Calypso.....	5,000	1912						5,000
	Faison.....	15,000	1912						15,000
	Inland Creek.....			30,000		30,000			30,000
	Rose Hill.....	20,000	1912						20,000
	Wallace.....	5,000	1912						5,000
	Warsaw.....	20,000	1912						20,000
Edgecombe—	Rocky Mount District			10,000		10,000			10,000
	Whitaker Township.....								
	No. 12.....								
	No. 13.....			200,000				200,000	200,000
	No. 14.....								
Forsyth—									
Franklin—	Franklinton.....	60,000	1909					100,000	100,000
	Louisburg.....	80,000	1909						80,000
	Youngsville.....	40,000	1911		40,000	40,000	Jan '14	40,000	160,000
Gaston—									
Gate—									
	Holly Grove.....	300,000	1905 and 1908						300,000
								6,500	6,500
									1,000

TABLE II—Continued.

County	Township or District	Bonds Issued to January 1, 1913	Date of Sale	Bonds Voted During 1913	Bonds Sold During 1913	Bonds Voted During 1914	Bonds Sold During 1914	Total Amount of Bonds Issued to January 1, 1915
Graham—	Cheoah.....	\$ 160,000	\$ 1903 and 1909	\$ 15,000	\$ 15,000	\$	\$	\$ 15,000
Granville.....	Bulls Head.....			20,000			20,000	160,000
Greene—	Hookertown Precinct.....			10,000			10,000	20,000
	Suggs Township.....			10,000			10,000	10,000
	Jason.....			20,000			20,000	10,000
	Olds.....			20,000			20,000	20,000
	Ormonds.....			10,000			10,000	20,000
	Shine.....			20,000			20,000	10,000
	Snow Hill.....	300,000	1905 and 1909	40,000			40,000	20,000
Gulford.....	Enfield.....			60,000		60,000	60,000	300,000
Halifax—	Halifax.....							100,000
Harnett—	Barbecue.....					10,000	10,000	60,000
	Black River.....					2,500	2,500	10,000
	Hector's Creek.....					15,000		2,500
	Lillington.....					20,000	20,000	15,000
	Upper Little River.....					20,000	20,000	20,000
Haywood—	East Fork.....					10,000		20,000
	Waynesville.....	50,000						10,000
Henderson.....	Edneyville.....					25,000	25,000	50,000
	Hendersonville.....					12,000		25,000
	Hooper's Creek.....					50,000	50,000	12,000
Hoke.....		50,000	1911	400,000	400,000			50,000
Iredell.....								400,000

Jackson—	Cullowhee.....			30,000			15,000	30,000
	Dillboro.....			15,000			15,000	15,000
	Sylva.....			30,000			30,000	30,000
Johnston—	Beulah.....						40,000	40,000
	Ingram.....						40,000	40,000
	Meadows.....						50,000	50,000
Lee.....		100,000	1912					100,000
	Sanford.....	15,000		200,000	200,000			15,000
Lincoln.....								200,000
McDowell—	Marion.....			50,000	50,000			50,000
	Nebo.....			10,000	10,000			10,000
	Old Fort.....			20,000	20,000			20,000
Macon—	Franklin.....			90,000			90,000	90,000
Madison.....				300,000	150,000		150,000	300,000
	Mars Hill.....	20,000						20,000
Martin—	Robersonville.....	20,000					15,000	15,000
	Williamston.....	300,000		10,000	10,000		10,000	40,000
Mecklenburg.....								300,000
Mitchell—	Grassy Creek.....						30,000	30,000
Moore—	Carthage.....	12,000		20,000			20,000	32,000
	Deep River.....			50,000				50,000
	Greenwood.....			12,500				12,500
	McNeill.....	10,000						10,000
	Mineral Spring.....			7,000				7,000
	Sand Hill.....	10,000		10,000				20,000
Nash—	Rocky Mount, R. D.	70,000	1907 and 1912					70,000
	N. Whitakers Twp.	50,000						50,000
	Cooper's Creek, R. D.			10,000	10,000			10,000
	Dry Wells, R. D.	20,000						20,000
	Griffin, R. D.	10,000						10,000
	Mannings, R. D.			50,000	50,000			50,000
	S. Whitakers, R. D.	10,000						10,000

TABLE II—Continued.

County	Township or District	Bonds Issued to January 1, 1913	Date of Sale	Bonds Voted During 1913	Bonds Sold During 1913	Bonds Voted During 1914	Bonds Sold During 1914	Total Amount of Bonds Issued to January 1, 1915
New Hanover.....		\$ 200,000	1902, 1905, 1907 and 1911	\$ 250,000	\$ 350,000			\$ 550,000
Northampton—								
Onslow—	Jackson Rich Square.....			30,000	10,000	16,000	16,000	16,000
	Jacksonville.....					20,000	20,000	50,000
Orange.....	Hillaboro.....	40,000	1908	250,000	230,000	7,500	7,500	7,500
Pasquotank.....								250,000
Pitt—								40,000
Polk.....	Greenville.....			10,000	10,000			10,000
Randolph—	Tryon.....	12,000	1911	50,000			50,000	50,000
	Randleman.....			100,000	100,000		50,000	100,000
Richmond.....								12,000
	Beaverdam.....	10,000				6,000	6,000	6,000
	Blackjack.....	5,000						10,000
	Mark's Creek.....	15,000	1905, 1907 and 1908					5,000
	Mineral Springs.....	5,000						15,000
	Rockingham.....	25,000						5,000
	Steele.....	15,000						25,000
	Wolf Pitt.....	25,000						15,000
Rockingham.....		24,000		250,000	250,000	30,000	30,000	25,000
Rutherford.....								54,000
Sampson.....		55,000				25,000	25,000	250,000
								80,000

Scotland--	Laurel Hill.....	1909 and 1911	30,000 20,000 50,000 30,000						30,000 20,000 50,000 30,000
	Spring Hill.....								
	Stewartsville.....								
	Williamson.....								
Stokes--	Danbury.....	1912	5,000	15,000				15,000	15,000
	Meadows.....			40,000				40,000	40,000
	Sauratown.....			50,000				50,000	50,000
Surry--	Mount Airy.....			80,000	80,000			20,000	105,000
Vance				200,000				200,000	200,000
Warren--	Warrenton.....	1905 and 1910	100,000					50,000	50,000
Wayne--	Brogden.....			40,000				40,000	40,000
	Goldboro.....			100,000				100,000	100,000
	Mount Olive.....							30,000	30,000
Wilson--	Wilson.....			150,000				150,000	100,000
Yancey									150,000
Totals.....			3,798,000	4,118,300	2,338,800	1,065,500	2,345,000		8,961,800

*Partly for bridges.

A review of this table shows that up to January 1, 1915, 24 counties and 120 townships had issued or voted bonds amounting to \$8,961,800; that of these, 3 counties and 36 townships voted bonds during 1914, amounting to \$1,065,500. In 1913 there were \$2,338,800 in bonds sold, and during 1914 \$2,345,000 worth of bonds were sold by 7 counties and 55 townships.

TABLE III

Classified Road Mileage.

This table gives road mileage by counties.

Column 1 gives, by counties, the total number of miles of public roads in the State. These figures are only approximately correct.

Column 2 gives by counties the total number of miles of macadam roads in the State.

Column 3 gives the number of miles of macadam roads constructed in the various counties during 1914.

Column 4 gives, by counties, the total number of miles of sand-clay or topsoil roads in the State.

Column 5 gives, by counties, the number of miles of sand-clay or topsoil roads built during 1914.

Column 6 gives, by counties, the total number of miles of gravel roads in the State.

Column 7 gives, by counties, the number of miles of gravel road built during 1914.

Column 8 gives, by counties, the total number of miles of specially surfaced road (including bituminous macadam, asphalt macadam, Tarvia, and concrete roads) in the State.

Column 9 gives the number of miles of specially surfaced road built during 1914.

Column 10 gives the kinds of surfacing material used in columns 8 and 9.

Column 11 gives, by counties, the total number of miles of road graded and shaped but not surfaced.

Column 12 gives the number of miles of road graded but not surfaced during 1914.

Column 13 gives, by counties, the number of miles of unimproved dirt road.

TABLE III. CLASSIFIED ROAD MILEAGE IN NORTH CAROLINA DURING 1914.

County	Number Miles Public Road	Total Number Miles Macadam	Number Miles Road Built 1914	Total Number Miles Sand- clay and Topsoil	Number Miles of Sand-clay and Topsoil Built 1914	Total Number of Miles of Gravel	Number Miles Gravel Built 1914	Total Number Miles of Spe- cially Surfaced Roads	Number of Spe- cially Surfaced Miles of Spe- cially Built 1914	Kind of Road Specially Surfaced	Total Number Miles Road Graded but Not Surfaced	Number Miles Road Graded but Not Sur- faced in 1914	Number Miles Unimproved Dirt Road
Alamance.....	600	50		8							8	5	734
Alexander.....	200												200
Alleghany*.....	300										20		280
Anson*.....	*500	15		32	19	36	15				13	13	404
Ashe.....	500												500
Avery.....	300												300
Beaufort.....	400			4	2	1							395
Bertie.....	800			20	5						200		580
Bladen.....	200			6	3						20	20	174
Brunswick*.....	*400			*48	*20						20	20	332
Buncombe.....	700	75		48	4			6		Asphalt Mac- adam.....	378	27.5	199
Burke.....	300			10	6								259
Cabarrus*.....	600	16		45	20						25		480
Caldwell.....	500	3		6	5						50	5	456
Camden.....	200										35	10	200
Carteret.....	200			20	10						10	7	170
Caswell.....	400	1.5											398.5
Catawba.....	450			100	25						20	10	330
Chatham.....	600										4	4	596
Cherokee.....	400	13	5	32	5	2	2				35		318
Chowan.....	185												185
Clay.....	135												135
Cleveland.....	800			80	30	25					15		680
Columbus.....	1,150			35	25	2					250	125	863
Craven.....	980			4							35	15	891
Cumberland.....	600			105	35						175		320
Currituck.....	100			3									97
Dare.....	70												70

*Estimated

TABLE III—Continued.

County	Number Miles Public Road	Total Number Miles Macadam Road	Number Miles Macadam Built 1914	Total Number Miles Sand- clay and Topsoil	Number Miles of Sand-clay and Topsoil Built 1914	Total Number of Miles of Gravel	Number Miles Gravel Built 1914	Total Number Miles of Special- ly Surfaced Road	Number of Spe- cially Surfaced Miles of Road Built 1914	Kind of Surfaced Road	Total Number Miles Road Graded but Not Surfaced	Number Miles Road Graded but Not Sur- faced in 1914	Number Miles Unimproved Dirt Road
Davidson.....	800	3		10	3						10	10	777
Davie.....	263			57	57						10	10	196
Duplin.....	800			66	10						10	10	794
Durham.....	450	97	1			16	7	5	5		15	7	317
Edgecombe.....	750			20	5						10	10	720
Forsyth.....	750	70		50	20	5		4	4	Tarvia.....	10	10	611
Franklin.....	*500			205	50			5	5	Bituminous Macadam.....	5	5	285
Gaston.....	*500	*110	*8	*40	*14						*5		345
Gates.....	300										20	20	280
Graham.....	*250			*3							2	2	245
Granville.....	700			135	10								565
Greene.....	300			40	40								280
Guilford.....	1,000	110		100	40	10							780
Halifax.....	600			80	55	20	6				10	10	490
Harnett.....	500			40	10						25	5	435
Haywood.....	300	20	4	60	60	2	2				100	35	340
Henderson.....	600			75	25						25	25	*600
Hertford*.....	200										100		200
Hoke.....	300			240	40						20		415
Hyde.....	700	25									20	20	380
Iredell.....	400			200	50						15	15	680
Jackson.....	900			4	4	36	15						206
Johnston.....	225			65	30								82
Jones.....	250			*100	*50								435
Lee.....	500			36	36						*20	*20	280
Lenoir.....	400										40	3	266
Lincola.....	350	8											
McDowell.....													

[illegible]

TABLE III—Continued.

County	Number Miles Public Road	Total Number Miles Macadam Road	Number Miles Macadam Built 1914	Total Number Miles Sand- clay and Topsoil	Number Miles of Sand-clay and Topsoil Built 1914	Total Number of Miles of Gravel	Number Miles Gravel Built 1914	Total Number Miles of Special- ly Surfaced Road	Number of Miles of Spe- cially Surfaced Road Built 1914	Kind of Specially Surfaced Road	Total Number Miles Road Graded but Not Surfaced	Number Miles Road Graded but Not Sur- faced in 1914	Number Miles Unimproved Dirt Road
Wayne.....	*1,000			*200	*50	*10	*5				*300	*20	*490
Wilkes.....	1,000	1									150	50	848
Wilson.....	800	24		35	9	1					40		700
Yadkin.....	300												300
Yancey.....	80			3	3						17	17	60
Totals.....	50,758	1,105	48½	4,363.5	1,610.5	502	211	56.25	15.25		4,181.5	1,290.5	40,549.75

A review of this table shows that the total mileage of public roads reported for 1914 was 50,758 miles, of which there were 1,105 miles of macadam, 4,363½ miles of sand-clay or topsoil; 502 miles of gravel; 56¼ miles of specially surfaced (concrete bituminous macadam, asphalt macadam, etc.); and 4,181½ miles of road graded but not surfaced. This makes a total of 10,208¼ miles of surfaced and improved road in the State, as reported for 1914. Of this mileage of improved road, the following were constructed during 1914:

48 1-6 miles macadam,
1,619 1-2 miles sand-clay or topsoil,
211 miles of gravel,
15 1-4 miles of specially surfaced,
1,290 1-2 miles of graded but not surfaced.

This leaves 40,549¼ miles of unimproved dirt roads in the State.

TABLE IV

Use of Convict Labor in Road Construction During 1914

This table gives the counties which use short-term prisoners on their own public roads and the counties which lease their convicts for road work to other counties. In a few instances the State, through special enactment, has undertaken to build certain roads with convict labor.

Column 1 gives the average number of convicts, by counties, used on the public roads during 1914.

Column 2 gives the names of counties to whom other counties leased their convicts during 1914.

Column 3 gives the average cost per day of guarding, feeding, and general care of convicts.

Column 4 gives the number of State convicts used in road work, by counties. The General Assembly of 1913 passed an act by which any county or township or good roads district may obtain State convicts by making application for them and by having their plans furnished or approved by the State Geological and Economic Survey. Roads built by such labor must be under the direction of the State Geological and Economic Survey.

Column 5 gives the opinions of those making the reports in regard to the effect of such work upon the convict and its value to the counties or the State.

Column 6 gives the estimated value in money of the convict labor used on the roads, estimating the number of days worked at 200 and the value per day per convict at \$1.25.

TABLE IV. USE OF CONVICT LABOR IN ROAD CONSTRUCTION IN NORTH CAROLINA DURING 1914.

County	Township	Average No. of Convicts Used	Leased Counties to Whom Leased	Average Cost Per Day of Guarding, Feeding, Etc.	State Convicts, Number	Value of Such Work to Convict and to County	Estimated Value of Convict Labor at \$1.25 Per Day
Alamance				\$			\$
Alexander							
Alleghany							
Anson		30		.75		Good results.	7,500
Ashe			Rockingham				
Avery							
Beaufort		30					7,500
Bertie		5		\$12 per mo.		This is what they should do.	1,250
Bladen							
Brunswick			Columbus	.75		Best use to be made of them.	37,500
Buncombe		150					
Burke		30		.65		Expensive without a large force.	7,500
Cabarrus			Catawba				
Caldwell			Pasquotank				
Camden			Craven and Edgecombe				
Carters							
Caswell							
Catawba			Leased				
Chatham							
Cherokee							
Chowan			Pasquotank				
Clay			Haywood				
Cleveland							
Columbus		35		.75		Good results under proper government.	8,750
Craven		25		.57½		The ideal work for them. Everything in favor of it.	6,250
Cumberland							
Currituck		28	Pasquotank	.50			

TABLE IV—Continued.

County	Township	Average No. of Convicts Used	Leased Counties to Whom Leased	Average Cost Per Day of Guarding, Feeding, Etc.	State Convicts, Number	Value of Such Work to Convict and to County	Estimated Value of Convict Labor Per Day at \$1.25
Dare.....				\$.....			\$.....
Davidson.....	Lexington.....	20					5,000
Davie.....			Guilford.....			The very best place for them.....	
Duplin.....		68		.60		Have all we can work of our own.....	17,000
Durham.....		40				Healthful and beneficial to general condition if properly cared for.....	10,000
Edgecombe.....						Convicts should be used on highways.....	32,500
Forsyth.....		130		.71			
Franklin.....						Worked well in Louisburg Township.....	6,250
Gaston.....	Louisburg.....	25				The only practical way of handling evil doers.....	12,500
Gates.....		50	Pasquotank.....				
Graham.....			Person.....			Approve of it.....	
Granville.....		9				Entirely satisfactory where properly handled.....	2,250
Greene.....		76		.50		The best way to handle them is on public roads.....	19,000
Guilford.....		30		1.00		It is specially good in that he is fitted to do valuable work while in service.....	7,500
Halifax.....							2,500
Harnett.....	(One township).....	10				Should be worked on county highways.....	5,500
Haywood.....		20-24		.80- .90	40	Where they all should be worked.....	14,500
Henderson.....		18	Halifax and Warren, Rich Square Twp., Northmp.			Proper thing.....	
Hertford.....							
Hoke.....							
Hyde.....							
Iredell.....		25		1.25		Do not approve of it.....	7,250
Jackson.....	Haywood.....						

Johnston.....	Smithfield-Clayton.....	20		1.00		All convicts everywhere ought to be worked on public roads. That is where they should be used.	5,000
Jones.....	Leased.....						
Lee.....	Union and Anson.....						
Lenoir.....		50		.45		With proper supervision it is very satisfactory.	12,500
Lincoln.....							
McDowell.....	Marion.....				30	Would do great deal of good for State prisoners to open up a few links.	
	Nebo.....					States should put her convicts on the roads of the State.	
	Old Fort.....					Do not have enough to justify working them.	
Macon.....	Haywood.....				35		
Madison.....							
Martin.....	Leased.....						
	Robersonville.....						
Mecklenburg.....	Williamston.....	100		.75			25,000
Mitchell.....						Don't think there can be any economy in it.	
Montgomery.....	Randolph and Stanly.....						
Moore.....	Leased.....						
	Bensalem.....						
	Greenwood.....					Can do more good on roads than anywhere else in State, as free labor think it is a low calling to work on public roads.	15,250
Naah.....							
	Naahville.....					Good thing.	
	Manning's Road District.....	10-12		1.00		Proper work.	
	Rocky Mount Road Dist.....	50		.89		The only proper place for convicts.	25,000
New Hanover.....		100		.71			5,000
Northampton.....	Rich Square.....	20					
Onslow.....							
Orange.....	Durham and Alamance.....						
Pamlico.....	Give them to other counties.....						
Pasquotank.....						Right thing for them.	7,500
Pender.....	Sampson.....	30				Most economical way if properly managed. They should work the county roads.	7,500

TABLE IV—Continued.

County	Township	Average No. of Convicts Used	Leased Counties to Whom Leased	Average Cost Per Day of Guarding Feeding, Etc.	State Convicts Number	Value of Such Work to Convict and to County	Estimated Value of Convict Labor at \$1.25 Per Day
Perquimans			Edgecombe	\$		Think the convict poor labor for the road.	\$
Person		38		.50		They should be used on public roads.	2,000
Pitt		40-45		.55			11,250
Polk	Greenville	30		.50			
			Henderson, Rutherford, McDowell, Gaston				
Randolph		10		1.00	50	Camps using them build good roads; in favor of it.	
Richmond		40		.60		Expensive but sometimes other labor not available.	2,500
Robeson		60		.64			10,000
Rockingham		60		1.00			15,000
Rowan		90				Very little cheaper than contracting roads.	15,000
Rutherford			Henderson				22,500
Sampson		20		.50		Best place to work them.	5,000
Scotland			Richmond				
Stanly		25		.85		In favor of it.	6,250
Stokes							
Surry			Rockingham			The place for them.	
Swain						O. K.	2,500
Transylvania		10		.75			
Tyrrell							
Union		30		.84		In favor of it.	7,500
Vance			Franklin and Warren				
Wake		79		1.00		Thoroughly pleased with results here.	19,750
Warren		14				Do not think much of it.	3,600
Washington		7				Good.	1,750
Watauga							

Wayne.....	35				Better than hired labor.....	8,750
Wilkes.....					Would be good plan.....	
Wilson.....	55				Think they should be so employed.....	13,750
Yadkin.....						
Yancey.....						
Totals.....	1,888					\$ 480,250

Table IV gives data in regard to the use of convict labor on the public roads in 1914. This shows that there were 1,888 short-term convicts used by the counties during 1914 and 155 State convicts. Thirty-one counties leased their convicts to other counties for use on public roads. The average cost for guarding, feeding, and general care of a convict ranges from 45 cents to \$1 per day. Estimating the value of the convict labor at \$1.25 per day per man and the number of days worked during the year at 200, gives the total value of convict labor for 1914 of \$460,250.

TABLE V

What Was Spent on Roads in 1914 and How It Was Spent

In this table is brought together the revenue from all sources (including taxes, subscriptions, bond issues, labor tax, convict labor, etc.) used on the public roads during 1914. None of the counties have kept exact figures in all cases as to the proportion of bond issues spent during this year, but it is believed that the figures given are fairly accurate. In this table is also given the number of miles of road surfaced and graded, together with estimated cost per mile of such improvements. Along with this statement is worked out the total amount spent in road construction during 1914 and an estimated statement as to the amount spent in the maintenance or upkeep of all the public roads during 1914.

Column 1 gives the funds from all sources except bond issues. This is given entirely by counties, but in many instances the sums given represent money raised by special taxes in certain townships. This, however, is given in detail in Table I.

Column 2 gives the estimated proportion of funds raised from bond issues spent during 1914. This is given by counties and townships.

Column 3 gives the estimated value of the free-labor tax, valuing it at \$1 per day per man.

Column 4 gives the estimated value of convict labor as worked out in Table IV.

Column 5 gives the total amounts from all sources spent on road work in 1914.

Column 6 gives the number of miles of macadam road built in 1914, and column 7 gives the cost per mile of this type of road.

Column 8 gives the number of miles of sand-clay or topsoil road built in 1914, and column 9 the cost of this type of road per mile.

Column 10 gives the number of miles of gravel road built in 1914 and column 11 the cost per mile.

Column 12 gives the number of miles of specially surfaced road (including asphalt macadam, bituminous macadam, concrete, etc.) built in 1914, and column 13 gives the cost per mile of these types of road.

Column 14 gives the number of miles of road graded but not surfaced during 1914, and column 15 gives the cost per mile for grading.

Column 16 gives the estimated total cost of roads graded and surfaced during 1914.

Column 17 gives the estimated amount spent on maintenance and repair during 1914.

Columns 16 and 17 do not represent all the money given in column 5, as in many instances a certain amount of the road tax is used for interest and sinking fund on bond issues and in some instances for bridge building or bridge maintenance.

TABLE V. WHAT WAS SPENT ON ROADS

County	(Bond Issues) Township	Funds from All Sources Except Bond Issues	Estimated Funds from Bond Issues	Estimated Value Labor Tax at \$1.00 Per Day	Estimated Value of Con- vict Labor at \$1.25 Per Day	Total Amounts Spent	Number Miles Macadam Built in 1914
Alamance.....		\$ 19,033.98	\$.....	\$ 6,000	\$.....	\$ 25,033.98	-----
Alexander.....		131.60	-----	9,000	-----	9,131.60	-----
	Ellendale.....	1,000.00	-----	-----	-----	1,000.00	-----
Alleghany.....		501.60	-----	9,800	-----	10,301.60	-----
Ans n.....		23,677.40	-----	12,000	7,500	43,177.40	-----
Ashe.....		20.00	-----	8,000	-----	8,020.00	-----
Avery.....		4,508.00	-----	-----	-----	4,508.00	-----
Beaufort.....		9,159.03	25,000	3,600	7,500	25,259.03	-----
Bertie.....		14,580.98	-----	12,000	1,250	27,830.98	-----
Bladen.....		6,625.60	-----	-----	-----	6,625.60	-----
	Brown Marsh.....	-----	5,000	-----	-----	5,000.00	-----
	Carver's Creek.....	-----	5,000	-----	-----	5,000.00	-----
Brunswick.....		5,600.40	-----	-----	-----	5,600.40	-----
	Northwest.....	-----	10,000	-----	-----	10,000.00	-----
	Shallotte.....	-----	5,000	-----	-----	5,000.00	-----
	Town Creek.....	-----	5,000	-----	-----	5,000.00	-----
Buncombe.....		61,424.16	50,000	11,340	37,500	92,764.16	-----
Burke.....		11,375.64	-----	-----	-----	11,375.64	-----
	Morganton.....	-----	10,000	-----	-----	10,000.00	-----
Cabarrus.....		32,080.60	25,000	-----	7,500	64,580.60	-----
Caldwell.....		2,639.40	-----	18,000	-----	20,639.40	-----
Camden.....		60.00	-----	6,000	-----	6,060.00	-----
Carteret.....		5,787.60	-----	-----	-----	5,787.60	-----
	Morehead.....	-----	5,000	4,800	-----	9,800.00	-----
	Newport.....	-----	5,000	-----	-----	5,000.00	-----
Caswell.....		5,412.80	-----	6,000	-----	11,412.80	-----
Catawba.....		27,214.05	-----	-----	-----	27,214.05	-----
	Hickory.....	-----	10,000	-----	-----	10,000.00	-----
	Newton.....	-----	10,000	-----	-----	10,000.00	-----
Chatham.....		10,124.56	-----	9,000	-----	19,124.56	-----
Cherokee.....		25,105.60	-----	3,600	-----	28,705.60	-----
	Murphy.....	-----	40,000	-----	-----	40,000.00	5
Chowan.....		5,831.80	-----	-----	-----	5,831.80	-----
Clay.....		1,113.00	-----	1,200	-----	2,313.00	-----
Cleveland.....		23,852.20	-----	-----	-----	23,852.20	-----
	No. 4.....	-----	10,000	-----	-----	10,000.00	-----
	No. 6.....	-----	15,000	-----	-----	15,000.00	-----
	No. 7.....	-----	5,000	-----	-----	5,000.00	-----
	No. 8.....	-----	5,000	-----	-----	5,000.00	-----
Columbus.....		13,775.40	-----	24,000	8,750	46,525.40	-----
Craven.....		29,579.40	-----	-----	6,250	35,829.40	-----
Cumberland.....		26,872.00	-----	-----	-----	26,872.00	-----
Currituck.....		143.60	-----	5,000	-----	5,143.60	-----
Dare.....		61.60	-----	3,000	-----	3,061.60	-----
Davidson.....		23,217.00	-----	6,000	5,000	34,217.00	-----
Davie.....		22,708.13	120,000*	-----	-----	142,708.13	-----
Duplin.....		5,604.40	-----	18,000	-----	23,604.40	-----
	Island Creek.....	-----	7,500*	-----	-----	7,500.00	-----
Durham.....		50,123.34	-----	-----	17,000	67,123.34	1
Edgecombe.....		31,882.13	-----	-----	10,000	41,882.13	-----
Forsyth.....		88,390.69	25,000	-----	32,500	145,890.69	-----
Franklin.....		21,157.20	-----	-----	6,250	27,407.20	-----
	Franklinton.....	-----	20,000	-----	-----	20,000.00	-----
	Louisburg.....	-----	40,000	-----	-----	40,000.00	-----

*Estimated.

DURING 1914, AND HOW IT WAS SPENT.

Cost Per Mile	Number Miles Sand-Clay and Topsoil Built in 1914	Cost Per Mile	Number Miles Gravel Built in 1914	Cost Per Mile	Number Miles Specially Sur- faced, 1914	Cost Per Mile	Number Miles Graded but Not Surfaced, 1914	Cost Per Mile	Estimated Total Cost of Roads Graded and Surfaced in 1914	Estimated Amount Spent in Main- tenance and Repair During 1914
\$.....	.....	\$.....	.....	\$.....	.....	\$.....	5	\$ 500	\$ 2,500	\$ 11,533.98
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,131.60
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,901.60
.....	19	200-350	15	600	.....	.....	13	600	22,015	20,562.40
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,020.00
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,508.00
.....	2	800*	.....	.....	.....	.....	.....	.....	1,600	23,659.03
.....	5	300*	.....	.....	.....	.....	.....	.....	1,500	25,330.98
.....	3	500*	.....	.....	.....	.....	20*	500*	11,500	3,125.60
.....	.....	.....	.....	.....	.....	.....	10*	500*	.....	.....
.....	.....	.....	.....	.....	.....	.....	10*	500*	.....	.....
.....	20	900	.....	.....	.....	.....	.....	.....	18,000	3,100.40
.....
.....	4	1,000	.....	.....	.....	.....	27.5	2,000	59,000	33,764.16
.....	6	1,000*	.....	.....	.....	.....	.....	.....	10,000	9,075.64
.....	6	1,000*	.....	.....	.....	.....	.....	.....	.....	.....
.....	20	1,500	.....	.....	.....	.....	5	1,000	35,000	29,580.60
.....	5	1,200*	.....	.....	.....	.....	10	800	14,000	6,639.40
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,060.00
.....	10	500	.....	.....	.....	.....	7	200	6,400	12,587.60
.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,412.80
.....	25	1,050	.....	.....	.....	.....	10	800	34,250	1,222.05
.....
.....	5	1,850	2	3,080	.....	.....	4	800	3,200	15,924.56
4,600	5	1,850	2	3,080	.....	.....	.....	.....	38,410	10,795.60
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,831.80
.....	30	1,000	.....	.....	.....	.....	.....	.....	30,000	2,313.00
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,852.20
.....
.....	25	350	.....	.....	.....	.....	125	200	33,750	8,775.40
.....	.....	.....	.....	.....	.....	.....	15	750	11,250	24,577.40
.....	35	600	.....	.....	.....	.....	.....	.....	21,000	5,872.00
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,143.60
.....	3	1,000*	.....	.....	.....	.....	10	750	10,500	3,061.60
.....	57	2,000	.....	.....	.....	.....	10	800	122,000	23,717.00
.....	10	600-1,000	.....	.....	.....	.....	10	50	7,500	10,708.13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21,604.40
5,000	.....	.....	7	2,250	5	2,800*	7	1,500-2,000	47,000	18,123.34
.....	5	1,000*	.....	.....	.....	.....	10	500	10,000	31,882.13
.....	20	1,800	.....	.....	4	8,000*	10	1,000	78,000	28,890.69
.....	50	500	1,000	.....	5	2,000*	5	500	62,500	11,007.20

TABLE V—

County	(Bond Issues) Township	Funds from All Sources Except Bond Issues	Estimated Funds from Bond Issues	Estimated Value Labor Tax at \$1.00 Per Day	Estimated Value of Con- vict Labor at \$1.25 Per Day	Total Amounts Spent	Number Miles Macadam Built in 1914
Gaston.....		\$ 43,757.00	\$.....	\$.....	\$ 12,500	\$ 56,257.00	8
Gates.....		1,796.08				1,796.08	
Graham.....	Holly Grove.....		6,500			6,500.00	
	Cheoah.....	5,133.00	3,000			5,133.00	
Granville.....		30,244.27		12,000		42,244.27	
Greene.....		11,105.26		12,000	2,250	25,355.26	
	Bulls Head.....		6,000			6,000.00	
	Hookertown						
	Precinct of Sugg		3,000			3,000.00	
	Township.....						
	Jason.....		3,000			3,000.00	
	Olds.....		6,000			6,000.00	
	Ormondsville.....		6,000			6,000.00	
	Shine.....		3,000			3,000.00	
	Snow Hill.....		6,000			6,000.00	
Guilford.....		89,708.00			19,000	108,708.00	
Halifax.....		33,924.60			7,500	41,424.60	
	Enfield.....		40,000			40,000.00	
	Halifax.....		60,000			60,000.00	
Harnett.....		9,698.40		9,000	2,500	21,198.40	
	Black River.....		2,500			2,500.00	
Haywood.....		18,374.20		18,000	5,500	41,874.20	4
	Beaverdam.....		10,000			10,000.00	
		10,584.40	25,000	3,000	14,500	53,084.40	
Henderson.....	Edneyville.....		12,000			12,000.00	
	Hendersonville.....		50,000			50,000.00	
Hertford.....		13,149.00		15,000		28,149.00	
Hoke.....		7,969.20	10,000			17,969.20	
Hyde.....		1,739.29				1,739.29	
Iredell.....		41,401.51	50,000		7,250	98,651.51	
Jackson.....		9,134.00		8,000		17,134.00	
	Cullowhee.....		15,000			15,000.00	
	Dillsboro.....		15,000			15,000.00	
	Sylva.....		30,000			30,000.00	
Johnston.....		36,349.24		10,800	5,000	52,149.24	
	Meadows.....		25,000			25,000.00	
Jones.....		7,478.79		2,000		9,478.79	
Lee.....		8,951.60	40,000			48,951.60	
Lenoir.....		54,332.12			12,500	66,822.12	
Lincoln.....		12,449.20	90,000*			102,449.20	
Macon.....		8,456.08		6,000		14,456.08	4
McDowell.....	Franklin.....		40,000*			40,000.00	
		21,930.59		12,000		33,930.59	
	Marion.....		25,000			25,000.00	
	Nebo.....		5,000			5,000.00	
	Old Fort.....		20,000			20,000.00	
Madison.....		10,922.70	130,000	9,000		149,922.70	
Martin.....		10,666.63		10,200		20,866.63	
	Robersonville.....		9,000			9,000.00	
	Williamston.....		5,000			5,000.00	
Mecklenburg.....		135,419.40		8,000	25,000	163,419.40	20
Mitchell.....		11,000.00		4,400		15,400.00	
	Grassy Creek.....		9,000			9,000.00	
Montgomery.....		22,609.89		8,000		30,609.89	

Continued.

Cost Per Mile	Number Miles Sand-Clay and Topsoil Built in 1914	Cost Per Mile	Number Miles Gravel Built in 1914	Cost Per Mile	Number Miles Specially Surfaced, 1914	Cost Per Mile	Number Miles Graded but Not Surfaced, 1914	Cost Per Mile	Estimated Total Cost of Roads Graded and Surfaced in, 1914	Estimated Amount Spent in Maintenance and Repair During 1914
\$3,000-4,000	14	700-1,250		\$		\$	20	325	\$ 41,650 6,500	\$ 14,607.00 1,766.08
							2	1,500	3,000	5,133.00
	10	250-1,500							8,750	15,894.27
	40	800							32,000	15,155.26
	40	1,000*							40,000	36,168.00
	55	1,300	6	2,100			10	600-700	90,600	40,824.60
	10	1,000*					5	600*	13,000	10,698.40
4,000*			2	2,000*					20,000	31,874.20
	60	800-1,000					35	500	71,500	27,584.40
										28,149.00
	25	500					25	100	15,000	2,969.20
										1,739.29
	40	1,650							66,000	14,651.51
							20	3,000*	60,000	17,134.00
	50	500					10*	200*	27,000	42,149.24
	4	500							2,000	5,478.79
	20	1,000	15	1,500					42,500	451.60
	30	1,000							30,000	36,822.12
	50*	1,500*					20*	1,000*	95,000	1,449.20
4,000*	5	1,800*					11	1,500*	41,500	7,956.08
							6			
	36	2,000					3	600-5,500	81,150	12,000.00
	20	2,000								
	6	2,000*								
	10	2,000*								
	4	3,000*					60	2,000*	132,000	9,000.00
	55	250*					5	50*	14,000	16,866.63
	15									
	40									
4,000	30	1,500							125,000	43,419.40
							3	3,000	9,000	15,400.00
	15	150	20	200			25	50	7,500	21,609.89

TABLE V—

County	(Bond Issues) Township	Funds from All Sources Except Bond Issues	Estimated Funds from Bond Issues	Estimated Value Labor Tax at \$1.00 Per Day	Estimated Value of Con- struction at \$1.25 Per Day	Total Amounts Spent	Number Miles Macadam Built in 1914
Moore.....		\$ 22,844.20	\$.....	\$.....	\$.....	\$ 22,844.20	-----
	Carthage.....		3,900			3,900.00	-----
	Mineral Springs.....		7,000			7,000.00	-----
Nash.....	(Road Districts).....	41,452.60			15,250	56,702.60	-----
	Coopers Creek.....		10,000			10,000.00	-----
	Rocky Mount.....		25,000			25,000.00	-----
	Mannings.....		30,000			30,000.00	-----
New Hanover.....		17,449.60	40,000*		25,000	57,449.60	1 $\frac{1}{2}$
Northampton.....		16,840.80		8,100	5,000	29,940.80	-----
	Jackson.....		8,000			8,000.00	-----
	Rich Square.....		4,000			4,000.00	-----
Onslow.....		4,550.20		4,800		9,350.20	-----
	Jacksonville.....		2,000			2,000.00	-----
Orange.....		20,171.20	215,000			235,171.20	-----
Pamlico.....		3,884.00		5,440		9,324.00	-----
Pasquotank.....		10,420.07	5,000		7,500	22,920.07	-----
Pender.....		7,382.00		11,200		18,582.00	-----
Perquimans.....		13,589.41				13,589.41	-----
Person.....		12,515.40			2,000	14,515.40	-----
Pitt.....		24,533.40		10,000	11,250	46,783.40	-----
	Greenville.....		40,000			40,000.00	-----
Polk.....		10,100.00	96,000	4,000		110,100.00	-----
Randolph.....		63,249.80		14,400	2,500	80,149.80	-----
Richmond.....		32,002.40	6,000		10,000	48,002.40	-----
Robeson.....		37,958.98		29,440	15,000	82,398.98	-----
Rockingham.....		29,053.60	30,000	5,920	15,000	79,973.60	-----
Rowan.....		54,742.40			22,500	77,242.40	3
Rutherford.....		16,954.01	250,000			276,954.01	-----
Sampson.....		14,493.60	25,000	18,000	5,000	62,493.60	-----
Scotland.....		25,093.80	10,000			35,093.80	-----
Stanly.....		13,783.60		4,240	6,250	24,273.60	-----
Stokes.....		20,416.80		12,000		32,416.80	-----
	Danbury.....		15,000			15,000.00	-----
	Meadows.....		40,000			40,000.00	-----
	Sauratown.....		50,000			50,000.00	-----
Surry.....		7,726.00		12,000		19,726.00	-----
	Mount Airy.....		58,000			58,000.00	-----
Swain.....		2,804.70		6,000		8,804.70	-----
Transylvania.....		8,326.70		6,000	2,500	17,326.70	-----
Tyrrell.....		512.40		9,000		9,512.40	-----
Union.....		22,265.75		21,000	7,500	50,765.75	2
Vance.....		18,305.55	100,000			118,305.55	-----
Wake.....		81,724.47			19,750	101,474.47	-----
Warren.....		13,054.60			3,500	16,554.60	-----
	Warrenton.....		17,000			17,000.00	-----
Washington.....		10,398.40		3,000	1,750	15,148.40	-----
Watauga.....		5,601.90		9,000		14,601.90	-----
Wayne.....		24,799.00		16,800	8,750	50,349.00	-----
	Goldboro.....		54,000			54,000.00	-----
Wilkes.....		9,641.40		30,000		39,641.40	-----
Wilson.....		38,874.40			13,750	52,624.40	-----
Yadkin.....		5,242.80		9,000		14,242.80	-----
Yancey.....		2,819.00	54,000	18,000		74,819.00	-----
Totals.....		2,044,738.28	2,422,400	591,080	460,250	5,406,945.18	48 $\frac{1}{2}$

Continued.

Cost Per Mile	Number Miles Sand-Clay or Topsoil Built in 1914	Cost Per Mile	Number Miles Gravel Built in 1914	Cost Per Mile	Number Miles Specially Surfaced, 1914	Cost Per Mile	Number Miles Graded but Not Surfaced, 1914	Cost Per Mile	Estimated Total Cost of Roads Graded and Surfaced in 1914	Estimated Amount Spent in Maintenance and Repair During 1914
\$	20	\$ 300*		\$		\$	5	\$ 200*	\$ 10,900	\$ 15,344.20
	13	300								
	29	800-1,000*	10	1,800*			125	400-500*	100,350	21,352.60
	25									
	4	800-1,000	2	1,800*			14	400-500*		
5,100	5	2,000*					9	1,382	41,828	15,621.60
			10	1,200					12,000	29,940.80
	5	400							2,000	9,350.20
	61	3,000	4	3,000*			12	1,600	214,200	4,971.20
										9,324.00
										22,920.07
	18	500*							9,000	9,582.00
							25	35	875	12,714.41
	5	1,500*							7,500	7,015.40
	45	850-1,000							45,000	17,408.40
	3	2,300					45	2,000	98,900	4,000.00
			75	500			5	250-350	39,000	41,149.80
	30	500	10	500			10	100	21,000	27,002.40
	35	1,000*					5	500*	37,500	44,898.98
							10	1,200	12,000	67,973.60
3,000	25	1,200					20	800	55,000	22,242.40
	14	1,500*					250	1,000*	271,000	5,954.01
	35	500							17,500	18,000.00
	40	500					5	200	21,000	8,093.80
	3*	2,100*					8	1,500	18,300	5,973.60
	65	1,500					5*	1,000*	102,500	12,000.00
	30	1,750					15	1,250	58,750	18,976.00
	2*	1,800*					3*	1,200*	7,200	1,604.70
	5*	1,800*					5*	1,200*	15,000	2,326.70
							6	50	300	9,212.40
2,100							8	1,000	12,200	38,565.75
	80	1,255							100,400	17,905.55
	25	300	30	300	1 1/2	8,800			27,500	73,974.47
	15 1/2	1,100							17,050	1,604.60
	10*	200					50*	50	4,500	10,648.40
										14,601.90
	50	750	5	1,000*			20	600	54,500	49,849.00
							50	500*	25,000	14,641.40
	9	1,000							9,000	43,624.40
										14,242.80
	3	4,200					17	3,200	67,000	7,419.00
	1,610 1/2		211		15 1/2	1,290.5			3,199,278	1,690,30

Table V gives a general statement in regard to expenditures on roads during 1914 from all sources and what was accomplished with these expenditures. This table shows that there was a total expenditure from all sources (taxes, bond issues, labor tax, and convict labor) during 1914 of \$5,406,945.18, of which \$2,044,738.28 was the expenditure from all sources except bond issues. There were \$2,422,400 from bond issues, and it is estimated that \$591,080 of free labor and \$460,250 convict labor were used in road work during 1914.

This table also gives the mileage of surfaced and graded road obtained from this expenditure, and shows that during 1914 there were 48 1-6 miles of macadam road constructed at an average cost of \$3,923 per mile; 1,619½ miles of sand-clay or topsoil at an average cost of \$1,180 per mile; 211 miles of gravel road at an average cost of \$2,113 per mile; 15¼ miles of specially surfaced road at an average cost of \$5,150 per mile; 1,290½ miles of road graded at an average cost of \$1,002 per mile.

It is estimated that \$3,199,298 were spent in surfacing and grading these roads during 1914, and \$1,690,307.59 in the maintenance and repair of the dirt and surfaced roads. Cost data, whether for construction or maintenance, have not been kept by any of the counties up to the present time.

TABLE VI

*Statement by Counties and Townships as to Administrative Boards
and Systems of Maintenance*

Column 1 gives the name of the board which controlled road matters during 1914, by counties and townships.

Column 2 gives the manner in which the public roads of the various counties and townships are maintained.

Column 3 gives, by counties, the estimated amount of tax money, value of free labor, etc., used in the maintenance or repair of the public roads during 1914.

Column 4 states whether or not the split-log drag is used in maintenance work, and what other implements were used.

Column 5 gives the sentiment in the county as reported as to use of wide tires.

TABLE VI. ADMINISTRATION AND MAINTENANCE.

County	Township	Administrative Board	How Roads are Maintained	Estimated Amt. of Tax Money and Value of Free Labor Used in 1914	Use of Drag	Sentiment Toward Use of Wide Tires
Alamance		County Com.	Free labor	\$ 11,533.98		
Alexander		County Road Com.		10,131.60	Not used	Nothing said.
Alleghany		County Com.		9,901.60		
Anson	(Balance of Co.)	County Com.	Free labor	20,562.40	Used	Favorable.
	Jonesboro	Township Road Com.				
	Morven	Township Road Com.				
Ashe		Township Trustees				
Avery		County Road Com.		8,020.00	Not used	Nothing said.
Beaufort		Township Road Com.		4,508.00		
Bertie		County Road Com.		23,659.03	Used in places	
Bladen		County Com.		25,330.98	Used	Slight.
Brunswick		County Com.		3,125.60		
Buncombe		Township Road Com.	Part of original bond issue	3,100.40	Used	Very little.
Burke		County Com.	Free labor and general fund	33,764.16	Used	Favorable.
Cabarrus		County Com.	Free labor and 20c levy	9,075.64	Used	Not much.
Caldwell		County Com.	Road fund	29,580.60	Used	None.
Camden		County Com.	Free labor	6,639.40	Used	Favorable.
Carleton		County Com.		6,060.00	Not used	None.
	(Balance of Co.)	County Com.	Special maintenance fund	12,587.60	Used	Favorable.
	Newport	Township Road Com.				
	Morehead	Township Trustees				
Caswell		Township Road Com.	10 cent tax	11,412.80	Not used	None.
Catawba		Township Road Com.	Balance of tax after interest and sinking fund			
			Free labor and tax	1,225.05	Road machine and drag	None.
Chatham		County Road Com.		15,924.56	Used	Favorable.
Cherokee		Highway Com.		10,765.60	Used	None.
Chowan		Township Trustees		5,831.80	Used	Not expressed.
Clay		Township Justices		2,313.00	Not used	Some.
Cleveland		Township Road Com.	Tax in each township	2,852.20	Used somewhat	Very much.
Columbus		County Road Com.	Special fund and free labor	8,775.40	Used	Growing rapidly.

Craven.....	County Com.....	Road tax primarily for maintenance.....	24,577.40	Used.....	Favorable. Considerable. None apparent.
Cumberland.....	County Com.....	Special fund.....	5,872.00	York State Road Home.....	
Currituck.....	County Com.....	Citizens help at times.....	5,143.60		
Dare.....	County Com.....		3,061.60		
Davidson.....	County Road Com.....		23,717.00	Used.....	Favorable.
Davie.....	County Road Com.....		10,708.13	Used.....	Favorable.
Duplin.....	County Road Com.....		21,604.40	Used.....	Favorable and growing.
	Island Creek.....	Special fund.....			
	Warsaw.....	Special fund.....			
Durham.....	County Com.....	Regular road fund.....	18,123.34	Used.....	Beginning.
Edgecombe.....	County Com.....	Road fund.....	31,882.13	Used.....	Favorable.
Forsyth.....	County Highway Com.....	Road fund.....	28,890.69	Used—one in each township.	Favorable.
Franklin.....	Township Road Com.....	Convicts are used.....	11,007.20	Not used.....	Some.
	Louisburg.....	Road tax.....	14,607.00	Steel drags to some extent.....	Some.
Gaston.....	County Com.....	Free labor—county furnishes bridges.....	1,796.08		Mentioned.
Gates.....	Township Road Com.....	Repair forces working all the time.....	5,133.00		
Graham.....	County Com.....				
Granville.....	County Com.....				
Greene.....	County Com.....	General road fund.....	15,894.27	40-50 given out in last 2 years.	Approve.
Guilford.....	County Com.....	Disorganized patch work.....	15,155.26	Steel drags.....	None visible.
Halifax.....	Co. Com., Co. Rd. Com.....		38,168.00	Used to some extent.....	Favorable.
	(Balance of Co.).....		40,824.60	Used.....	Some.
Enfield.....	Township Road Com.....				
Halifax.....	Township Road Com.....				
Harnett.....	County Road Com.....	Free labor.....	10,698.40	Used.....	Some.
Haywood.....	County Com.....		31,874.20		
	(Balance of Co.).....				
	Waynesville.....				
Henderson.....	Co. Com., Tp. Trustees.....	Free labor.....	27,584.40	Used.....	None discussed.
Hertford.....	Township Road Com.....	Road fund.....	28,149.00	Used.....	Some.
Hoke.....	County Com.....	Special fund.....	2,969.20	Used.....	None.
Hyde.....		Special tax for 2 yrs.....	1,739.29		Law for county.
	Fairfield.....				Favorable.
	Swan Quarter.....				
	Other Townships.....				
Iredell.....	Road Com.....				
	Township Road Com.....				
	County Com.....	Special fund.....	14,651.51	Used.....	Favorable.

TABLE VI—Continued.

County	Township	Administrative Board	How Roads are Maintained	Estimated Amt. of Tax Money and Value of Free Labor Used in 1914	Use of Drag	Sentiment Toward Use of Wide Tires
Jackson.....		Township Road Trustees.....	Free labor and special tax.....	\$17,134.00		None.
Johnston.....		Township Road Supervisors.....	Convict force.....	42,149.24	Used.....	Very strong.
Jones.....		Road Com.....	Road tax; optional tax.....	5,478.79	Used.....	
Lee.....		County Road Com.....	Money left after interest and sinking fund.....			
Lenoir.....		County Com.....	General fund.....	451.60	Used.....	Favorable.
Lincoln.....				38,822.12	Scrapers and heavy steel drags.....	Favorable.
McDowell.....				1,449.20		
	Marion.....	Township Road Com.....	Road tax.....	12,000.00	Steel drag.....	Not much.
	Nebo.....	Township Road Com.....	Free labor.....		Steel drag.....	Not very much.
	Old Fort.....	Township Road Com.....	Tax.....		Split-log drag.....	Favorable.
Macon.....		Township Trustees.....	Township tax.....	17,956.08	Not used.....	Favorable.
Madison.....		County Road Com.....		9,000.00		Quite favorable.
Martin.....				16,866.63	Used.....	Some.
	Robersonville.....	Township Trustees.....			Used.....	Some.
Mecklenburg.....		Township Trustees.....	Raised by taxation.....	43,419.40	Used.....	None.
Mitchell.....		Co. Com. and Tp. Trustees.....		15,400.00		
Montgomery.....		County Road Com.....	Part of road fund used.....	21,809.80	Used.....	Very favorable; special act.
		Co. Com. and Tp. Trustees.....				
Moore.....				15,344.20	Used.....	Favorable.
	Benaalem.....	Township Road Com.....				
	Greenwood.....	Township Road Com.....				
	Mineral Springs.....	Township Road Com.....	Regular fund used primarily for maintenance.....		Used all the time.....	Favorable.
Nash.....				21,352.60	Not used.....	Favorable.
	Bailey's Rd. Dist.....	Township Road Com.....			Used.....	Not discussed.
	Manning's Rd. D. Dist.....	Road Com.....				
	Rocky Mount Rd. Dist.....	Road Com.....	General fund.....		Steel drags.....	None apparent.

New Hanover	County Com.	Convicts supported by bond money		Used	Slight, but growing. Very little.
Northampton	Road Com.		15,631.60	Used	
Onslow	Township Trustees		29,940.80	Used	
Orange	County Com.		9,350.20		
Pamlico	County Com.	Road fund.	4,971.20	Not used	Not apparent. Some.
Pasquotank	County Highway Com.	Patch work by convicts	22,920.07		
Pender	County Com.		9,582.00	Used	
Perquimans	County Com.	General road fund.	12,714.41	Not used	Some.
Person	County Com.		7,015.40	Used—also steel drags	None apparent. Some.
Pitt	County Com.		17,408.40	Used	
Polk	Co. Com. and Rd. Com.		4,000.00		
Randolph	Highway Com.		41,149.80	Used	Little consideration. given it.
	Co. Com. and Tp. Rd. Com.	Taxes and labor.			Has wide-tire law.
Richmond	County Com.	Special fund.	27,002.40	Used	
Robeson	Co. Com. and Tp. Trustees	2% general road fund	44,888.98		
Rockingham	County Com.	General road fund.	67,973.60	Used	None.
Rowan	County Com.	General road fund.	22,242.40	Used	Favorable.
Rutherford	County Road Com.		5,954.01	Used	Very little.
Sampson	Road Com.		18,000.00	Used	Slight.
Scotland	Township Road Com.		8,083.80		
Stanly	Township Road Com.		5,973.60		
		Free labor.		Used	None.
Stokes	Township Highway Com.		12,000.00		
Surry	Township Road Com.	Road tax fund.	18,976.00	Used	Some. Favorable.
	Road Trustees		1,604.70	Used	
Swain	Township Overseers		2,326.70		
Transylvania	Township Road Com.	Free labor.	9,212.40	Used	None.
Tyrell	Township Road Com.	Taxes	38,565.75	Used	None apparent.
Union	County Road Com.	Special fund.	17,905.55	Used	Favorable.
Vance	County Com.	Taxes and part of bond issue	73,974.47	Used	Favorable.
Wake	Co. Com. and Tp. Com.		1,604.60	Used with splendid results	Favorable.
Warren	County Com.	General fund.	10,648.40	Steel drags	None as yet.
Washington					

TABLE VI—Continued.

County	Township	Administrative Board	How Roads are Maintained	Estimated Amt. of Tax Money and Value of Free Labor Used in 1914	Use of Drag	Sentiment Toward Use of Wide Tires
Watauga.....		County Com.....	Free labor.....	\$14,601.90	.....	.....
Wayne.....	(Balance of Co.)..	County Com.....	Free labor.....	49,849.00	Used.....	None known. Some.
	Goldsboro.....	Township Trustees.....				
Wilkes.....		Township Supervisors.....		14,641.40	.....
Wilson.....		County Com.....		43,624.40	Used.....	Favorable.
	Tolant.....	Township Road Com.....				
Yadkin.....		County Com.....		14,242.80	.....	Favorable.
Yancey.....		County Road Com.....		7,419.00	.....

Table VI gives the statement, by counties and townships, as to administrative boards and systems of maintenance. This gives in detail the counties which use the road drag and other implements in the maintenance of roads, and the attitude of the various counties as to the use of wide tires. In this table, also, is stated the kinds of administrative boards in the various counties and townships.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
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27. The Altitudes of North Carolina, 1917. 8°, ... pp. *Postage .. cents. In press.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analysis of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virginina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Cogging (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, . . pp. *In press.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. *In press.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy \$1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 75 cents. Cloth-bound copy \$1 extra.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. 11.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV.—The Birds of North Carolina—*In press.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, pp. *Postage .. cents.*

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

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EIGHTH ANNUAL DRAINAGE CONVENTION

NORTH CALIFORNIA DRAINAGE ASSOCIATION

HELD AT THE UNIVERSITY OF CALIFORNIA
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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 45

PROCEEDINGS
OF
EIGHTH ANNUAL DRAINAGE CONVENTION
OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION

HELD AT
BELHAVEN, NORTH CAROLINA
NOVEMBER 29, 30, AND DECEMBER 1, 1915

COMPILED BY
JOSEPH HYDE PRATT, State Geologist
AND
MISS H. M. BERRY, Secretary



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1917

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., May 1, 1916.

*To His Excellency, HON. LOCKE CRAIG,
Governor of North Carolina.*

SIR:—There was held at Belhaven, Beaufort County, N. C., on November 29th, 30th, and December 1st, 1915, the Eighth Annual Drainage Convention. This convention was held under the auspices of the North Carolina Drainage Association in coöperation with the North Carolina Geological and Economic Survey. The papers presented at this convention were of great interest, and it is believed that these, together with the discussions in regard to the various phases of the drainage problem, are of great interest and value to the State and those interested in the reclamation and utilization of these swamp and overflowed areas. I therefore recommend that a compilation of these proceedings be published as Economic Paper No. 45 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

C. S. L., - Economic Survey, 12-6-17g

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PROCEEDINGS

OF THE

EIGHTH ANNUAL DRAINAGE CONVENTION

HELD UNDER THE AUSPICES OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION AND THE NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY

BELHAVEN, N. C., NOVEMBER 29, 30, AND DECEMBER 1, 1915

COMPILED BY
JOSEPH HYDE PRATT, STATE GEOLOGIST
AND MISS H. M. BERRY, SECRETARY

MONDAY, NOVEMBER 29, 1915—Evening Session

The Eighth Annual Convention of the North Carolina Drainage Association was called to order Monday evening, November 29th, at 8 o'clock, in the city hall of Belhaven, by the Secretary, Mr. Joseph Hyde Pratt, the President, Mr. Lawrence Brett, being absent.

MR. PRATT: In calling the Convention to order I want to make the announcement that I am not President of the Association. I am very sorry to say that we have just had a telegram from Mr. Brett, stating that he has been detained at Great Falls, S. C., in connection with some development work he is carrying on for the Southern Power Company. I think this is the first of the eight conventions that Mr. Brett has not been able to attend, and I have been asked to preside in his place.

Tonight I will have to act in the dual capacity of President and Secretary, and for this reason I am going to ask the reporters here to assist as secretaries of this Convention. I am going to call on first, the Mayor of Belhaven, Mr. Tooley.

ADDRESSES OF WELCOME

MR. JOHN G. TOOLEY, for the Town of Belhaven:

Gentlemen of the Convention, Ladies and Gentlemen: I am not mayor of the town of Belhaven, but the privilege of expressing the welcome for the town has fallen to my lot, and, while I deeply appreciate the honor, I feel keenly alive to my inability to do justice to it. Our means in Belhaven for entertainment are rather limited, but our joy at having you with us and having the Convention assemble here is without bounds, and if we can succeed in making you enjoy the occasion as much as we ourselves do, then we will have reached the full measure of success. If there is one thing more

than another that is claiming the attention, and the serious attention, of the people of the State of North Carolina at the present time, it is drainage. The subject is being discussed everywhere; the air is permeated with it and in this section of the country the dogs bark it; the birds sing it; the pines sigh it; and old Pungo River mourns it. It is wonderful to me that so many thousands of acres of land, waste and desolate, with practically no taxable or commercial value, have been, through the successful application of drainage systems, transformed into profitable farm lands. Within a radius of twenty-five miles from where we are tonight there are at least 35,000 acres of swamp lands which have been converted so that they will yield as much per acre as the old farm lands yield. I hope I will be pardoned for relating an incident that occurred last August when a gentleman from Indiana was taken up to a section where thousands of acres of land are stuck in corn. The process is to cut the growth in September, burn it off in May and then stick it in corn, and it produces a yield of from five to fifteen barrels per acre. This gentleman was from the Wabash bottoms of Indiana, which I believe is the best corn section of the country. The land we were going over was a dense forest less than a year previous to his visit and, according to his estimation, it would yield at least eight barrels of corn to the acre. At first he could not let belief take hold of him, but finally he admitted that it was the most marvelous production under the circumstances that he had ever seen. I asked him if he would not, when he returned to Indiana, write the facts and have them published in the *State Farm Journal*. He made this reply: "If I were to do that those people up there would brand me as a notorious liar. The only way they could be made to believe that this land down here is so fertile would be for them to come and see with their own eyes as I have seen." Within a few short months the most gigantic venture ever undertaken in drainage in the State of North Carolina, and perhaps the United States, will be completed and 48,000 acres of lake bottom will be drained and placed on the market at a good value.

Although drainage is in its infancy, the results have added millions of dollars to the wealth of the State, and its people and the personnel of this Convention shows that there are brains behind the movement. The annual mobilization of such forces as we have with us tonight is significantly prophetic of untold good to the State and its people, and I bespeak for the Convention a profitable and enjoyable meeting in the town of Belhaven.

The Chairman then called upon Mr. P. H. Johnson, who made the address of welcome on behalf of the Belhaven Board of Trade.

MR. P. H. JOHNSON, for the Board of Trade of Belhaven:

Mr. President, Ladies and Gentlemen of the Convention: It gives me peculiar pleasure to welcome the North Carolina Drainage Association to Belhaven, for myself, and in behalf of the Board of Trade of this town.

In discussing the land improvement schemes and the immense drainage projects which we have undertaken, it is an invariable custom to speak of the work as being in Belhaven and vicinity, and since my friend Mr. Tooley has said all that could be said for Belhaven, I shall be compelled to enlarge my welcome so as to include the vicinity as well. I am glad to say that I can branch out as far as I like without exceeding the scope of endeavor of your commercial body.

Living in another town as I do, I am at liberty to praise your Board of Trade as much as I desire without seeming unduly boastful or egotistic, and I am glad to say that it is composed of men who early realized that the continued growth and prosperity of your town could only be guaranteed by fostering the development of the country round about it.

Guided by this inspiration, actuated by a desire to see Belhaven take the place among her sister towns to which her splendid location entitles her, these men have worked in an ever widening sphere until they have drawn so distinguished a body as the North Carolina Drainage Association within the circle of their influence.

And now that we have you gentlemen with us, the Board is particularly anxious that something be said that will, to use an old expression, "Haunt you to the place."

They have charged me with a great responsibility and I am sensibly reminded of my incompetence. I am expected to make an appropriate speech, and in a way I have tried to create the impression that I was able to do so. Now it is up to me to tell you all that I am somewhat like an old negro who lived right near Vanderbilt's game preserve at Biltmore.

One evening a game warden drove up to the old negro's house and, without revealing his identity, called out, "Hello, uncle! Have you any game about here?"

"I should say we have, boss," John replied.

"What sort of game have you?"

"Well, we have squirrels and quail, and wild turkeys, and quite often we see a deer."

"Do you ever go hunting?"

"Yes, sir, boss, I went out this morning."

"What did you kill?"

"I killed four squirrels and five partridges, and I went hunting last Monday morning and killed a big deer."

At this statement the game warden produced a pair of handcuffs and, snapping them on the old negro's arms, said: "Come, go with me; you are the man that has been shooting down here. I've been looking for you a long time."

John looked at his bracelets and then looking at the game warden, said: "Boss, you sho is got me dis time, ain't you?"

"Yes, I've got you."

"But, boss, does you know who I is?"

"No, who are you?"

"I'm de biggest Mar in North Carolina. I never have been hunting in my life."

I must reluctantly confess that my case is very similar to the old negro's. I have made a good many scattering remarks trying to create the impression that I was able to do more, and now that the Board of Trade has "got" me, I am compelled to own that I never delivered a real speech in my life. However, a man may not be an orator and yet he may be thrilled with an honest pride in his community and a desire for its development, and he may be possessed with that spirit of hospitality which, while unexpressed, will somehow make itself known to the stranger and will inspire him with that secure knowledge of welcome which has immortalized the word "home." We

would have you feel that it is such a spirit which dominates us, and it is such a welcome that we extend to you tonight.

We are particularly glad to have this Convention in Belhaven. You must know that the State Drainage Law very largely had its conception in this community, and while Pantego Drainage District was the third to organize in the State, it really started construction before the law was enacted; and it was perhaps the need which was here emphasized that started the movement that culminated in the organization of the State Drainage Association and the enactment of our present Drainage Law. At that time this district was represented in the Senate by one of our citizens, Hon. F. P. Latham, and we are glad to say that to a very large extent, it was due to the untiring effort which he put forth in its behalf that our Drainage Law was placed upon the statute books in its original form unsullied by the various amendments with which its enemies tried to hamper it.

In view of these facts we cannot but feel that in coming to Belhaven the North Carolina Drainage Association is coming home, and, while we do not wish to imply that you are a prodigal, we do want you to experience the same bountiful welcome which he enjoyed and we trust that your entertainment may be as pleasant as was his participation in the fatted calf of old.

I have watched the State Drainage Association from its very beginning, and while it has encountered many difficulties, I am glad to say that it has always triumphed. I recently read a little poem which ran something like this:

A little cork fell in the path of a whale,
Who lashed it down with his angry tail;
But in spite of his blows it quickly arose,
And floated serenely before his nose.

Said the cork, "You can splutter and splash and flap,
But you never can keep me down.
For I'm made of the stuff which is buoyant enough
To float instead of drown."

I thought how beautifully this little poem described the struggles of the State Drainage Association, and how truly it depicted the reason for its success. Antagonized by big corporations, impeded by learned lawyers, pressed down by hostile influences, it has quickly arisen from the ashes of apparent defeat and continued steadfastly on towards the mark of the high calling whereunto it had aspired because of the fact that it was made of the stuff which would float instead of drown.

There is perhaps no section of the State which has reaped a greater benefit from the labors of these men than has this community. Within a radius of just a few miles we have over a hundred miles of canals cut by dredges serving over one hundred and fifty thousand acres of land, while next door to us is the largest drainage project ever undertaken in this State. I refer to the drainage of Lake Mattamuskeet. We have thousands of acres of land which only a few short years ago were considered worthless, and which now, thanks to the North Carolina Drainage Association, have shown themselves rich beyond the most avaricious dreams of man.

Touched by the magic wand of drainage development tall reeds have given place to taller corn; where once the bear and wildcat held communion with

their mates, blooded stock now graze in peaceful contentment; wild briars have disappeared and roses bloom and flourish in their stead, lading the air with sweet perfume; and deep within the heart of this erstwhile impenetrable wilderness, giant trees which once sheltered the wild things of the forest now stand as mighty sentinels at the gates of men who, even in this short time, have seen that the land was good, have gone forth to possess it, and are now dwelling happily within the shadow of their own vine and fig tree.

I want to say to you gentlemen that the State owes you a debt which it never can repay. You have set in motion a movement, the value of which no man may measure, and I believe that some day your names will go down in history as the foremost workers of your age. I believe that our children will rise up and call you blessed, and that the God of the harvest will pour a bounteous benediction on your heads because of the fact that you have enriched the world by making two blades of grass to grow where only one grew before.

Again I welcome you.

MR. PRATT: I think, for a man who cannot make an address, that the representative of the Board of Trade has done mighty well. One thing he did, though, and that is, he used a little bit of my thunder. I was going to say the same thing about the next speaker that the representative of the Board of Trade has said, and I knew nothing of that story of the Vanderbilt negro.

The next speaker that we will call upon is one who did a great deal for the passage of the North Carolina Drainage Law at the 1909 Session of the General Assembly. He represented this district in the Senate and introduced the bill that became the North Carolina Drainage Law. He did not, like many men who go to the General Assembly, introduce the bill and then forget all about it and leave it to take its own course; but he stayed right behind that bill until it was passed and signed. I take pleasure in introducing to you Honorable F. P. Latham, who will speak to us on behalf of the County Commissioners of Beaufort County.

MR. F. P. LATHAM:

Ladies, Mr. President, and Gentlemen of the North Carolina Drainage Convention: Only a few moments ago, since I came into this hall, was I requested to fill in a gap in the program of arrangements occasioned by the absence of the chairman of our Board of County Commissioners, who was scheduled to welcome you gentlemen of the Eighth Annual Drainage Convention to Beaufort County. I do not feel that I have been given the squarest of deals in thus being thrust into the oratorical company of such gentlemen as have preceded me; they have certainly assembled some appropriate thoughts connected with the purpose of this gathering.

It may not be amiss if I indulge in a little reminiscence of the early history of conditions leading up to the formation of plans for practical drainage on a big scale in North Carolina.

In the summer of 1908 a convention was called to meet at Morehead City for the purpose of devising ways and means to improve drainage that was in use, and to provide some plans to make the vast swamp lands of Eastern North Carolina valuable from an agricultural standpoint. It was attended by a number of the best men of the State who had great public interest in the subject. From a multitude of counsels plans were formulated for the purpose of pressing an act before the ensuing Legislature which would make it possible to form vast areas into drainage districts and bond the lands to pay for the improvements.

I was approached by a gentlemen whom I now see before me, to make a stand, and fight for the nomination to the next General Assembly. After conferences with my friends I made the fight and won, and this with drainage as my purpose. The law as drawn by the committee appointed by the Morehead Convention was intrusted to, and introduced by me; being fortified by the able assistance of such men as Dr. Pratt, Mr. J. O. Wright, Senators Van B. Martin and Oscar L. Clark, the law which is now in operation was ratified practically as first introduced. To you, gentlemen, I say that the selection of this town as your meeting place was entirely fitting. From this very hall twenty-five miles to the west a vast agricultural gold mine is being opened by drainage, twenty-five miles to the north is a continuation of wonderful lands only accessible by a system of drainage, fifty miles to the east the vast agricultural Eldorados have only been tickled on the edges, and they, too, await the beneficial effect of drainage to become a valuable asset to our country.

We welcome you, gentlemen; we welcome any move that tends to hasten the date when these lands will be subjected to cultivation, for when this is done, this town will at once advance to and remain at the head of the list as a stock and grain market of all North Carolina. Now, gentlemen, you will note that every one you meet is interested in drainage; the subject is vital to us. We wish to again welcome you; the long latch string hangs from the outside of every home. Your presence in Beaufort County we know will be profitable to us, and we hope pleasant to you.

RESPONSE TO ADDRESSES OF WELCOME

MR. PRATT:

Ladies and Gentlemen and Members of the Association: It is with a great deal of pleasure that I respond to these most cordial addresses of welcome. It is indeed fitting that we should hold one of the conventions of the North Carolina Drainage Association in the town of Belhaven, Beaufort County, because as one of the speakers has said, the beginning of drainage was really in Beaufort County; and, while the actual cutting of that first canal was not entirely for the purpose of draining swamp lands, but was partly to provide a right of way for a railroad, it did demonstrate and illustrate that drainage of the swamp lands of Eastern North Carolina was a feasible and practicable proposition. This first canal was started just north of here and follows what is now the cut-off of the Norfolk Southern Railroad. That work was done by the Wilkinson Brothers. They were not satisfied with simply digging one canal. They wanted to preach the doctrine of drainage, and they found it such an awfully big proposition that two men could not do all the preaching necessary to inform the people of Eastern North Carolina what the drainage

of the swamp lands meant, and so they called others in; Honorable John H. Small, Congressman from this district; Johnson of Pantego; and Van Martin of Plymouth; and the result was the organization of the North Carolina Drainage Association at a meeting held in New Bern in the fall of 1908.

I can remember the first trip I made down here in Eastern North Carolina in the interest of drainage. I do not know whether I am accustomed to bragging a good deal about North Carolina and the possibilities of certain sections and what North Carolinians can do when they once get started, but I did have the nerve (if you may call it that) to get up in two or three meetings down here in Eastern North Carolina in 1907 and 1908 and state that the swamp lands of North Carolina could be drained and would make good agricultural lands. The first year the only encouragement I got outside the men I mentioned, was from a man representing the Southern Railway, and he stated that if it could be done it would be one of the best things that could happen in Eastern North Carolina. The trouble was he put a lot of emphasis on that word "if." The drainage law was not passed until 1909 and all this work, the drainage of the swamp lands of Eastern North Carolina and the overflowed lands of Piedmont North Carolina, has been done since the year 1909, when the Drainage Law made it possible to organize the drainage districts and carry out the drainage projects. You have in this vicinity approximately 100 miles of drainage canals. How I wish you also had 100 miles of good roads! The two things that will do most for North Carolina, Eastern North Carolina, are the drainage of her swamp lands and the construction of good roads. Now you have here in Beaufort County demonstrated by the actual construction of 100 miles of canals that drainage is feasible, practicable, and profitable; if you will build five miles of good road in Beaufort County, I think you will demonstrate that good roads are also feasible and also very profitable to Beaufort County. Now, taking the two together, with the drainage you have opened up thousands and thousands of acres of the richest land in the United States for cultivation, and with good roads you will make that land accessible to market. Your roads are not now in the condition they should be to attract and interest outsiders to come in here and begin to cultivate the lands that you have drained. I had an inquiry come into the office just before I left, one man wanting a thousand acres of land that is to be drained or land that is drained in Eastern North Carolina. Another inquiry came from a man from the West who is now in Charlotte, who wishes to invest in drained swamp lands. I wonder if you people of Belhaven and Beaufort County realize as I do what you have right here in Beaufort County, with Washington as well as Belhaven as centers. You have here belts that overlap. If you take a map of North Carolina, showing what we call the tobacco belt, the cotton belt, the peanut belt, the truck farming, and the fishing industry, every one of these belts overlaps in portions of Beaufort County. You have more, perhaps, in this general vicinity in natural resources than in any other section of North Carolina. We don't realize what we have right down in this general section.

I want to correct a statement Mr. Johnson made, and that was that the Wabash was the best corn land in the country. I am willing to call that the second best; but the best corn land in the United States is right around here in portions of Beaufort, Hyde, and Tyrrell counties, and in this general belt. I am not the only one who can talk up North Carolina. I think we have that spirit of standing up for the State, and it is spreading right down to the

smaller children. I remember one of the little girls from Chapel Hill who was visiting her aunt in Tennessee. They took her to church on Sunday at which service the minister made a very fervent prayer for rain. It did not rain Monday nor Tuesday; but on Friday it did rain, and at the dinner table her aunt remarked that the minister's prayer had been answered. This little girl piped up and said: "Shucks, that's nothing; in North Carolina when the minister prays for rain on Sunday, it always rains by Tuesday."

Now there is another reason why I am glad we met at Belhaven at this time, and that is that the people who are interested in the drainage work in North Carolina will have an opportunity to visit perhaps the most unique drainage proposition or problem that has ever been taken up in this country. It is not possibly the largest area, as we have a larger one in Florida, but I think you have the most unique drainage proposition in the Lake Mattamuskeet project because the drainage of that district, which, altogether, comprises 120,000 acres, is being done partially by gravity, but the final drainage can only be accomplished by pumping, as the bottom of the lake is several feet lower than the surface of Pamlico Sound. We will have an opportunity to visit that district before it is completed. We will see the installation of the tremendously large pumps that are necessary to take care of the water, some with an intake of six feet. It may be several years, perhaps five, before all these pumps will be needed again to take care of the water that will come from some cloudburst into that drainage basin, but the plant must be ready to take care of the water if we do get a cloudburst, and we will have a chance to see it before all the water is pumped out. We can also see something regarding the quality of the soil of the bottom of the lake because they have diked off a small area which has been planted in corn the past season. That district has been advertised all over the country, and the question that is put up to me constantly is, Will it pay? Will it be a profitable proposition? I leave it to you what I told them.

I can remember the first time I came to Belhaven. It did not look in any way like it does today. I don't think I know of any town in North Carolina that has made a better, more substantial growth than Belhaven, and I believe from what has been said on this platform this evening that its future growth is assured. With the continued growth of these districts in this section, Belhaven is bound to become one of the big markets. I want to see a grain elevator here, as I believe there is no other one thing that would do more to build up Belhaven and Beaufort County than such an elevator. Why couldn't we have one here in North Carolina? I believe it would do more to stimulate the production of corn than perhaps anything we could do. Connect Belhaven with Washington, with Columbia, and with Plymouth by good roads, and you have an outlet to the north. Then, again, there is another thing that will build up Belhaven. I wonder if you ever thought of Belhaven as a winter resort or a summer resort. But after all, the thing that would help to build it up more than anything else is good roads. I believe you have the climate and other things that would make this section attractive not only for winter but for summer visitors, but you cannot build it up that way unless you have a system of better roads so that you can get in and out. Now, I like Chapel Hill, but if I felt I could not get out of Chapel Hill, I would not want to live there. The good roads will do more to build up a section than any other one thing we have.

This year we are bragging about the hundred miles of drainage canals in Beaufort County; next year let's be bragging about nearly a hundred miles of good roads.

I don't want to take up too much time as "Mr. Brett," because I have to talk a little as "Secretary." I will tell you a story in which the word "sufficient" was used which will illustrate what I want. Two Irishmen got into a dispute as to which was the better man, and they decided the only way to settle this was to have a regular fight. They did not want any witnesses, so they decided to get out behind a building and have it out, and the one who was ready to quit first was to holler the word "sufficient." The bigger of the two finally managed to get the other fellow down and kept pounding at him for quite a while, but the other fellow was getting in some good licks, too. Finally the fellow on top yelled "sufficient," and the one on the bottom said, "Thank the Lord. I have been trying to think of that word for the last half hour."

I can assure you that we are, as representatives of various sections of North Carolina, very glad to meet here at Belhaven, and we thank you, gentlemen, for the cordial addresses of welcome that you have made to us, and I know we are going to enjoy every minute that we spend in Belhaven; and that, while at the end of the Convention we will have to go away, it won't be because we will want to go away from this most delightful place.

SECRETARY'S REPORT

Mr. Joseph Hyde Pratt, the Secretary, submitted as his report the published proceedings of the Seventh Annual Drainage Convention. This report was accepted and approved by the Convention.

TREASURER'S REPORT

The report of the Treasurer showed a balance on hand November, 1914, of \$97.99. Receipts during 1915 amounted to \$41, making a total of \$138.99. Expenditures during 1915 amounted to \$118.75, leaving a balance December 1, 1915, of \$20.24.

This report was referred to an auditing committee, composed of Mr. John Wilkinson of Belhaven and Mr. M. W. Thompson of Greensboro.

TUESDAY, NOVEMBER 30, 1915—Morning Session, 9:30 o'clock

MR. PRATT: The First Vice-President of the Association will be presiding officer of this morning's session.

MR. JOHNSON: This is rather a surprise to me. However, those of you who were at Wilson last year probably remember that I told you if you would come to Belhaven we would show you soil richer than you ever saw and a sky bluer than you ever saw, and we would convince you that the farther east you came, the nearer you would come to your Creator. Since it is by the grace of God that we are permitted to assemble again, we will now open the Convention with a prayer by the Reverend Hayes Farrish:

OPENING PRAYER

"Our Father in Heaven, in Thy name and through Thy new and living way that has been opened up to us, even that way that reveals to us the Fatherhood of God and the power of the Creator, we come and approach Thy throne of grace at this hour; and as we come in the interest of this organization and this Association that means so much to the development of the community, to the development of the State and to the advancement of civilization, we cannot but thank Thee that Thou hast impressed upon the hearts and minds that there is music in the running brooks; that there are sermons in the pebbles that are washed by the waters in the earth; and that there is good in everything. We realize that Thou hast given man dominion over the earth. He has grappled the air and controlled it. He has mastered the earth upon which he treads, but there is still a great vast outreach of territory that is not yet completely subjugated to the good of the world. We thank Thee for this Association that contends for the development of the undeveloped. We thank Thee that Thou hast given to the sons of the earth the power to be tillers of the soil. We thank Thee that we can read the story of the earth upon the surface and that we can explore and find the hidden resources thereof. We thank Thee that we can use all of these things for the good of the community; that we can use them for the service of humanity; that we can use them to the glory of God. We thank Thee, our Father, that Thou art not unmindful of Thy children, but revealest to man the objects of nature; and wilt Thou help us to look beneath the rugged undergrowth on the surface and search for the hidden treasures that lie in the pockets of the earth and as we bring forth these treasures to the light, through scientific investigation and experiment, wilt Thou help us to use them to Thy good and Thy glory. Wilt Thou bless the messages that they bring to this community; wilt Thou bless the decisions that shall be made. Wilt Thou bless every effort that is put forth and work that is effected in this gathering, that it may be for the good of humanity and for the advancement of Thy truth. Wilt Thou bless us now while we further deliberate during the hours of these sessions, and use us to some thing and some glorious service, through Jesus Christ, our Lord, Amen."

APPOINTMENT OF COMMITTEES

The Secretary then announced the appointment of the following Committees:

COMMITTEE ON RESOLUTIONS

M. F. H. Gouveneur, <i>Chairman</i>	New Hanover County
Van B. Martin.....	Washington County
Honorable John H. Small.....	Beaufort County
J. A. Wilkinson.....	Beaufort County
E. B. Hopkins.....	Tyrrell County
R. O. Bagley.....	Currituck County
Professor M. E. Sherwin.....	Wake County
W. H. Waters.....	Craven County
J. A. Porter.....	Gulford County
F. B. Daniels.....	Wayne County
W. F. Heckstall	Bertie County
Zeno Moore	Edgecombe County

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

R. E. Snowden, <i>Chairman</i>	Craven County
D. B. McNeill.....	Robeson County
E. D. Spruill.....	Washington County
W. T. Hopkins.....	Washington County
F. K. Borden, Jr.....	Wayne County
F. R. Baker.....	Wake County
M. W. Thompson.....	Gulford County
J. D. Goldsmith.....	Mecklenberg County
J. W. Cooper	Bertie County
C. Van Leuven.....	New Hanover County
J. R. Barnhill.....	Pitt County
M. E. Chappell.....	Hyde County
J. C. Cowley.....	Wilson County

MEMBERSHIP COMMITTEE

George Old, <i>Chairman</i>	Beaufort County
Miss H. M. Berry.....	Orange County
E. S. Askew.....	Bertie County
H. M. Lynde.....	Wake County
J. W. Martin.....	Pitt County
J. L. Phelps.....	Washington County
D. A. Cox.....	Currituck County

LEGISLATIVE COMMITTEE

M. F. H. Gouveneur, <i>Chairman</i>	Wilmington, N. C.
John H. Small.....	Washington, N. C.
W. W. Pierce.....	Goldsboro, N. C.
M. W. Thompson.....	Greensboro, N. C.
A. H. Eller.....	Winston-Salem, N. C.
W. D. Alexander.....	Charlotte, N. C.
Jas. B. Armfield.....	Statesville, N. C.
Lawrence Brett	Wilson, N. C.
P. H. Johnson, President.....	Pantego, N. C.
Joseph Hyde Pratt, Secretary.....	Chapel Hill, N. C.

MISCELLANEOUS BUSINESS

Mr. PRATT: There is one notice that I would like to give out, and that is in regard to the death of one of the active members of this Association during the past year. While he did not live in North Carolina, yet he was one of the active members of the North Carolina Drainage Association and was extremely interested in everything that is being done toward the development of Eastern North Carolina. I refer to Mr. B. E. Rice, Land and Industrial Agent of the Norfolk Southern Railway. Out of respect to him and his memory I would like to ask the members of the Convention to rise. (Convention rises.)

I think his work and the interest he took in our Association was a big help to the work in this State. He has attended nearly every Convention held, has taken part in these Conventions, and each time has brought us some word in regard to the railroad he represented and its interest in the drainage work in North Carolina. We miss him at this Convention; we miss his words of advice and suggestions in connection with the future work of the Association.

There is another thing to which I would call your attention. You will notice in the program handed out that there is a list of the Drainage Districts in North Carolina. I wish the members would take that list and go over it, and make any corrections in the way of subtractions or additions necessary to bring it up to date. This is the list that we have in the office of the Geological Survey.

Mr. JOHNSON: I am denied the privilege of introducing our next speaker—he so aggressively introduced himself last night in so many capacities. However, I do want to say that no man in North Carolina is so well qualified to discuss our North Carolina Drainage Law as is Dr. Pratt, and no other man in the State has given so much of his time and thought to the furtherance of this drainage movement; and I know without saying anything further, that no one who hears Dr. Pratt speak on our State Drainage Law, who is really interested in drainage, can go away feeling other than that his time has been well spent.

I take pleasure in presenting Dr. Pratt, who will talk to you about the State Drainage Law.

THE NORTH CAROLINA DRAINAGE LAW

By JOSEPH HYDE PRATT, State Geologist

The North Carolina Drainage law was passed by the General Assembly of North Carolina in 1909, and represented a bill that had been worked out very carefully by a committee of the North Carolina Drainage Association, who considered it, at the time they worked for its passage by the General Assembly, as nearly a perfect drainage law as could be drawn at that time. It was

realized, however, after the law had been in operation for some time, that certain amendments were necessary to make it more effective. A committee of the Drainage Association took up the question of amendments, and by the time the General Assembly of 1911 had convened they were ready with a bill which had the endorsement of the Association to be introduced in the General Assembly of 1911. These amendments, together with the original law of 1909, represented the drainage law in operation until 1915. A brief summary of this law to 1915 is something as follows:

When it is desired to start the organization of a drainage district, a majority of the landowners, or those owning three-fifths of the area of the lands to be drained, must file a petition with the clerk of the Superior Court of the county or counties in which the lands lie, setting forth the fact that they wish to drain these lands and that it will be for the public benefit. Then, summons is served upon all the other landowners in the proposed district who did not join in the petition. At the end of a certain number of days, after the service of the summons, the clerk hears the petition, and nothing appearing to the contrary, it is his duty to grant the petition, and to order viewers appointed consisting of one drainage engineer and two freeholders in the proposed drainage district. This board of three viewers is instructed to go upon the lands, to ascertain if there are any lands in the proposed district which ought not to be in the district; if so, to exclude them; if there are any lands which ought to be in and are not; and if so, to include them; whether it is susceptible of drainage and whether or not the public will be benefited. Then they make their report to the clerk of the Superior Court. The clerk advertises that a hearing of the report will be held on a certain day, at which time he either confirms or modifies or rejects the report. Any landowner has the right of appeal from the judgment of the clerk of the Superior Court, either that he is included and ought not to be included, or that he is not included and ought to be, or any other part of the report affecting any substantial right of his property.

Now, after that report is confirmed, and if it is not appealed from, the clerk of the court directs the board of viewers to go upon the lands again, to survey out the boundary lines of the landowners, to go on each tract of land, and to classify it as to benefits; the lands most benefited Class A, the next Class B, the next Class C, and so on. The board of viewers, through the engineer, are required to make the plans for the drainage of those lands and then to estimate the cost of same. After they have completed this work, they again file a report ("final report") with the clerk of the Superior Court. Notice is given to landowners to come in and view the report and make objections if they have any. At the end of that time the clerk hears and considers any objections. He overrules objections or approves them, as the case may be, and after the whole matter is considered he approves it, entirely or in modified form.

Any landowner dissatisfied with the clerk's decision, may appeal to the Superior Court in term time and have the judge pass upon the law and a jury upon the facts; or he can take it up to the Supreme Court, the point being that the rights of each landowner are subserved. When approved, the landowners can appoint three commissioners, and upon their election, the drainage district at once becomes a corporation, these three commissioners become directors of that corporation, and the district is given a name, as

Currituck County Drainage District No. 1. This drainage district has all the powers of any other corporation. The commissioners then prepare to issue the bonds authorized.

These are advertised for sale, but cannot be sold for less than par. The interest and principal of the bonds are levied and collected as regular taxes and the bonds are a lien on the land next to State and county taxes.

The commissioners also advertise for bidders to construct the drainage works in accordance with the plans of the engineer. They enter into a contract with the lowest bidder—the lowest, if there is no reason why they should reject his bid. The contractor enters into a bond for the faithful performance of his work, and then they appoint a superintendent of construction to see that it is carried out. From the proceeds of the bonds, the contractor is paid from time to time for his work, based upon his monthly reports, but ten per cent is withheld to the end, as a guaranty. The commissioners appoint a competent engineer or superintendent to supervise the work of contractors.

Several appeals have been made to the Supreme Court of North Carolina regarding decisions of the lower courts relative to the interpretation of the North Carolina Drainage Law, and in every instance the decision of the Supreme Court has been favorable to the Drainage Law. These decisions have very materially improved the market for the sale of drainage bonds and has really made them gilt-edge securities.

In this connection, I wish to emphasize the absolute necessity that every single detail of the law shall be carried out in regard to the organization of the district and the issuing of the bonds, for upon this will depend the legality and, therefore, the salability of the bonds.

In order to assist in the organization of these drainage districts the North Carolina Geological and Economic Survey has had prepared a set of blank forms that covers each step that should be taken in organizing a district.

The Association has continually urged that no amendments be made to the North Carolina Drainage Law except such as have been approved by it, this Association being made up of the men in North Carolina who are particularly interested in the reclamation of our swamp and overflowed lands.

At the General Assembly of 1915 certain amendments were recommended by the Association, but the General Assembly failed to adopt them. On the other hand, they did adopt amendments which had not been approved by the Association, and in their passage, due to an error in the engrossing clerk's office, a very serious handicap has been placed upon the drainage work of the State. The amendments that were passed are as follows:

AMENDMENTS TO NORTH CAROLINA DRAINAGE LAWS MADE BY LEGISLATURE OF 1915.

CHAPTER 43

AN ACT TO AMEND CHAPTER 442 OF THE PUBLIC LAWS OF 1909, RELATING TO DRAINAGE.

The General Assembly of North Carolina do enact:

SECTION 1. That chapter four hundred and forty-two of the Public Laws of one thousand nine hundred and nine be amended by inserting after the word "land" in line five of section thirty, and before the word "is" the following:

"be of such elevation that the owner cannot secure proper drainage through and over his own land, or if said land."

SEC. 2. That this act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 18th day of February, 1915.

CHAPTER 235

AN ACT TO REPEAL SECTION 14 OF CHAPTER 67 OF THE PUBLIC LAWS OF 1911, RELATING TO ADVANCEMENTS MADE TO DRAINAGE DISTRICTS BY THE STATE TREASURER.

The General Assembly of North Carolina do enact:

SECTION 1. That section fourteen of chapter sixty-seven of the Public Laws of one thousand nine hundred and eleven be and the same is hereby repealed.

SEC. 2. That upon request of the Department of Agriculture the Attorney-General shall bring in the Superior Court of Wake County an action against the drainage commissioners of any drainage district that has failed or may hereafter fail to refund any money advanced by the State Treasurer under the provisions of section fourteen, chapter sixty-seven of the Public Laws of one thousand nine hundred and eleven, the said action to be brought both against the board of drainage commissioners and the bond of the petitioners for the establishment of the district required by section two of chapter four hundred and forty-two of the Public Laws of one thousand nine hundred and nine.

SEC. 3. This act shall be in effect from and after its ratification.

In the General Assembly read three times and ratified this the 9th day of March, 1915.

CHAPTER 238

AN ACT TO AMEND CHAPTER 442 OF THE PUBLIC LAWS OF 1909, RELATIVE TO THE DRAINAGE OF SWAMP AND OTHER LANDS.

The General Assembly of North Carolina do enact:

SECTION 1. That section two of chapter four hundred and forty-two of the Public Laws of one thousand nine hundred and nine be and the same is hereby stricken out and the following substituted and enacted in lieu thereof: "It shall be the further duty of the engineer and viewers to assess the damages claimed by the owners of any land located in such proposed drainage district, and to embrace in such assessment the value of any land actually taken and the injury done to any land not taken, including damage to the growing crops and timber located thereon, as well as all inconveniences suffered by such landowners, on account of such proposed drainage or other improvements. Such damages, when assessed and ascertained, shall be considered separate and apart from any benefits such land might receive because of the proposed improvements, and shall be included in the total cost of such improvements, and collected in the manner provided for the collection of other moneys to defray the costs of said improvements under the provisions of this act, and when so collected shall be paid by the board of drainage commissioners to the person or persons entitled thereto."

SEC. 2. That section sixteen of said act be amended as follows: By inserting between the words "assessed" and "is," in line eight of said section, the words "in the manner provided in section eleven hereof," and between the

words "assessed" and "is," in line eleven of said section, the words "in the manner hereinbefore provided."

SEC. 3. That all laws and clauses of laws in conflict with this act are hereby repealed: *Provided*, the same shall not affect any proceedings now pending for the drainage of any lands under this act.

SEC. 4. That this act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 9th day of March, 1915.

The error consisted in substituting the word "two" for the word "eleven," so that instead of repealing section 11 of chapter 442 of the Public Laws of 1909, section 2 is apparently repealed. Thus far no case has been taken up to the Supreme Court to determine whether this act would interfere with the organization of a drainage district as outlined above, or would invalidate bonds issued by a district since the passage of this act. It is hoped that in the future the North Carolina Drainage Association can have sufficient influence with and the confidence of the members of the General Assembly, so that they will not pass any amendments to the Drainage Law which are not first approved by the Association.

The recommendations that the Association made to the General Assembly of 1915 are as follows:

AMENDMENTS TO THE NORTH CAROLINA DRAINAGE LAW

(Suggested by the Legislative Committee of the North Carolina Drainage Association to the Legislature of 1915.)

A BILL TO BE ENTITLED AN ACT TO AMEND CHAPTER 442 OF THE PUBLIC LAWS OF 1909, ENACTING A GENERAL DRAINAGE LAW AND PROVIDING FOR THE ESTABLISHMENT OF DRAINAGE DISTRICTS, AND THE ACT AMENDATORY THEREOF, BEING CHAPTER 67 OF THE PUBLIC LAWS OF 1911.

The General Assembly of North Carolina do enact:

SECTION 1. That section 14 of chapter 67 of the Public Laws of 1911 be, and the same is hereby repealed, and in lieu thereof the following section shall be substituted:

That the State Treasurer shall pay the compensation and expenses of the Drainage Engineer and his necessary assistants as provided in section 2 of chapter 442 of the Public Laws of one thousand nine hundred and nine, which payment shall be based upon an itemized statement approved by the clerk of the Superior Court before whom the drainage proceedings is pending, and also approved by the State Geologist. Such payment shall be made upon the warrant of the State Auditor out of any money in the treasury not otherwise appropriated. The total amount to be paid by the State Treasurer shall not exceed at any one time the sum of fifteen thousand dollars (\$15,000) after deducting the amounts refunded to the Treasurer from time to time. Before any warrant shall be drawn by the Auditor or payment made by the Treasurer the bond of the petitioners required by section 2 of the said chapter shall be first approved by the Attorney-General. Not more than two thousand

dollars (\$2,000) shall be advanced to any one drainage district. The amount so paid or advanced to any drainage district shall be refunded to the State Treasurer by the board of drainage commissioners out of the first moneys which shall come into their hands from the sale of bonds or otherwise if the district shall be established, or the same shall be refunded by the petitioners or the sureties on their bond in the event the district shall not be established. If the drainage district is established and the board of drainage commissioners shall fail to refund to the State Treasurer such sum or sums as may have been advanced to the district out of the first moneys which shall be paid to the district either from the sale of bonds or otherwise, then each of the members of said board of drainage commissioners shall be guilty of a misdemeanor and be fined or imprisoned at the discretion of the court. As a further remedy the State Treasurer is hereby authorized and directed to institute suit against the board of drainage commissioners in their corporate capacity for the amount so advanced by the State Treasurer. If the district shall not be established, and if the petitioners in the proceeding for the district shall not refund to the State Treasurer the amounts so advanced within sixty days after the court has adjudged against the establishment of the district, then the said Treasurer is authorized and directed to institute suit in the Superior Court of the county in which the district is sought to be established against all the petitioners and the surety or sureties on their bond.

SEC. 2. That section 12 of chapter 442, Public Laws of 1909, be amended by striking out all after the words "construction of the ditch," in line eight, and inserting the following in lieu thereof:

The lands benefited thereby shall be separated into eight classes. The land receiving the highest benefit shall be marked "Class A"; that receiving the next highest benefit, "Class B"; that receiving the next highest benefit, "Class C"; that receiving the next highest benefit, "Class D"; that receiving the next highest benefit, "Class E"; that receiving the next highest benefit, "Class F"; that receiving the next highest benefit, "Class G"; and that receiving the smallest benefit, "Class H."

The lands of any one landowner need not necessarily be all in any one class, but may be in different classes according to benefits received. The number of acres in each class as to each tract of land shall be ascertained and reported, but the boundaries of each class need not be marked on the ground or shown on the map.

It shall be the duty of the engineer and viewers to survey and have prepared a map showing the boundary lines of the district, the boundary lines of each tract of land owned by each person, or several persons jointly, and also to compute and show the number of acres therein and mark the name of the owner on the map. In their report they shall also show the total number of acres owned by each landowner in each class, and the total number of acres benefited thereby computed and shown. The total number of acres in each class in the entire district shall be determined and presented in tabulated form.

The scale of assessment upon the several classes of land returned by the engineer and viewers shall be in the ratio of eight, seven, six, five, four, three, two and one; that is to say, as often as eight mills per acre is assessed against the land in "Class A" seven mills per acre shall be assessed against the land in "Class B," six mills per acre shall be assessed against the land in "Class C," five mills per acre in "Class D," four mills per acre in "Class E," three

mills per acre in "Class F," two mills per acre in "Class G," and one mill per acre in "Class H." This scale shall form the basis of assessments of benefits to lands for drainage purposes.

SEC. 3. The boundaries of lands as surveyed and mapped, the ownership thereof and the classification and assessment thereof as appears upon the assessment roll shall be and remain as of the time when the district was established and the final report of the board of viewers approved by the court. No conveyance or devise of land or devolution by inheritance after the owner thereof has been served with the original summons, either by personal service or by publication, shall affect the status or liability of such land as a part of such drainage district, except as hereinafter provided.

If the owner or owners of any lands included in such district shall, after being served with the original summons, and before the engineer and viewers shall survey and classify the same, convey the whole or part of such lands, then, and in such event, the owner and grantee may file a petition before the clerk of the Superior Court setting forth the facts, with a description of the land conveyed either in part or the entire body of land, and attach a map in duplicate of such land conveyed and such portion, if any, reserved and not conveyed, and praying that the grantee be made a party to the proceeding; whereupon the court may make the grantee a party and shall certify to the engineer and viewers a description of the land so conveyed and copy of the map, with directions to verify the boundaries and classify the said land to the same extent as if the grantee was the original party. Such part of the lands not so conveyed shall be and remain a part of the district.

After the district shall be established, the lands classified and the assessment roll filed, no conveyance of any land in the district shall affect or change the existing status or liability of such lands as to assessment charges or otherwise, except in the manner herein defined. Before any conveyance and delivery of deed, or at any time thereafter, the original owner or owners of land and the grantee or proposed grantee may jointly serve written notice on the chairman of the board of drainage commissioners that on a certain day they will move before the clerk of the Superior Court to amend the final report of the board of viewers and assessment roll, which motion may be based upon a petition and map filed with the clerk. Such petition shall contain a description of the lands in the district claimed by the owner as recited in the final report and assessment roll, and description of the land conveyed, or proposed to be conveyed, the name of the grantee, and such other facts as may be pertinent and shall pray the court to amend the final report of the board of viewers and the assessment roll by adding the name of the grantee as one of the landowners of such district and by amending the assessment roll accordingly. The petitioners shall file with the court at the same time a map showing the entire land of the owner and the part conveyed, or proposed to be conveyed, which map shall be attached to the petition. Copy of the petition and map shall be delivered to the chairman of the board when the notice is served upon him. If the entire body of land claimed by the owner or owners, as appears in the final report and assessment roll, has been conveyed or is proposed to be conveyed, then it shall not be necessary to file a map with the petition, and the court may, after a hearing, make an order amending the final report as to the name of the owner of the land, and substituting the name of the grantee upon the assessment roll. If only a part of the land claimed by the original owner has been conveyed or is proposed to be con-

veyed, as appears by the petition and map, then the court shall make an order referring the petition to the board of drainage commissioners with instructions to verify the description and map and to ascertain in which class or classes the land so conveyed should be placed, and the amount of the tax assessment upon the same during the remaining years for which the bonds or other liability shall be outstanding and the assessments are to be paid, and report their findings to the court. The board of drainage commissioners shall submit their report to the court within twenty days thereafter, unless the time shall be extended by the court. The petitioners may file exceptions to this report within fifteen days after the same shall be filed with the court. At any time after fifteen days from the filing of the report the court shall, after previous notice of five days to the petitioners and the chairman of the board, or their attorney, proceed to consider the report and find the facts and make an order amending the final report, and, also, by adding the name of the grantee or grantees to the assessment roll, under such classification and with such assessment as may be just in the premises. If for any reason the grantee and grantor or the devisee and heirs at law cannot agree upon the terms of a joint petition to the court, the petition may be filed by any one of them, but notice shall be given to the remainder. If the title and ownership of any lands in the district, in whole or in part, shall pass and vest in another person or persons by devise or by inheritance, then, and in such event, such devisees or heirs at law may file their petition in the court and be entitled to all the remedies provided herein. If the ownership and title of more than one tract of land in the district has become vested in other persons, either by grant, devise or inheritance, then all of the new owners may join in a common petition to the court as hereinbefore provided. In no event shall such a change in the classifications or assessment be made as to the land conveyed as shall reduce the aggregate amount assessed against the entire land for each remaining year as appears upon the original assessment roll. The board of drainage commissioners under the direction of the court shall amend the assessment roll and tax levy for the several remaining years as appears from the original assessment rolls by readjusting the assessment against the original owner and by adding the names of the grantees or new owners thereof. The assessment roll may be amended in the body thereof or at the end thereof in the discretion of the court, and in such manner as the court may direct. The notice herein required to be served upon the chairman shall be taken as a notice to the entire board of drainage commissioners and the chairman shall be presumed to be acting for the board under the provisions of this section. The chairman acting for the board shall represent and protect the interests of the drainage district and may appear and answer the petition. If any member of the board of drainage commissioners shall own land in the district and shall convey the same in whole or in part the remaining members of the board may act under this section and, if the chairman or other member shall be the grantor or grantee, then notice may be served upon either of the remaining members of the board. The chairman or the board may employ an engineer or surveyor, if necessary to do so. This section shall apply to land-owners in districts heretofore established in the same manner and to the same effect as to proceedings now pending for the establishment of districts, or hereafter instituted, and shall also apply to conveyances hereafter made.

All necessary costs accruing under this section shall be paid by the petitioners. The procedure as to special proceedings shall apply to this section.

Where the title and ownership of any tract or tracts of land embraced in the district has been changed or vested in another or others by grant, devise or inheritance subsequent to the establishment of the district, the assessment roll may be amended in the following manner, which shall constitute an alternative method. The grantor and grantee or the new owners in whom title has vested by grant, devise or inheritance, and the chairman of the board of drainage commissioners of the district may enter into an agreement setting forth the description of the original land as recited in the assessment roll and the description of the portion thereof which has been conveyed, or a description of that part or parts, the title to which has become vested in new owners by devise or inheritance, also the classification of such lands and the amount of tax assessment against the same vested in the new owner or owners, the tax assessment to be stated for the several remaining years for which assessments were levied in the original assessment roll. Such reclassification and reassessment shall not reduce the aggregate assessments against the original tract of land as appears from the original assessment roll. Such agreement may be presented to the clerk of the Superior Court who shall inquire into the truth of the facts or statements agreed upon and after satisfying himself as to the same, and particularly that the aggregate assessment upon the original tract of land has not been reduced, the said clerk shall make an order directing that the original assessment roll be amended by adding the name of the new owners to each annual assessment roll with the amounts assessed against each, and by amending the assessment against the original owner if he has reserved any part of the land originally held by him. The amendments to the assessment roll may be made either by the chairman of the board of drainage commissioners or by the clerk of the court in the original assessment roll, and may be noted either in the body of the assessment roll or at the end thereof, in the discretion of the chairman or the clerk. After the agreement herein provided has been made and signed by the necessary parties, the chairman of the board of drainage commissioners of the district is authorized to present the same of his own motion to the clerk of the court. Any number of grantors and grantees and new owners of any tract of land in whom title has become vested since the establishment of the district may join in one agreement with the chairman of the board of drainage commissioners, but the facts as to each change of title where the land is held in severalty shall be stated separately. If any grantor or grantee or new owner of land shall be a member of or chairman of the board of drainage commissioners the agreement herein provided may be signed by one of the remaining members of the board.

All proper costs accruing hereunder shall be paid by the grantor or grantee or new owners before the order amending the assessment rolls shall be made by the clerk.

Any amendments to the assessment roll made after September first in any year shall not go into effect or be operative in the hands of the sheriff or tax collector until September first of the succeeding year when the next assessment shall become due and payable.

SEC. 4. That section 19 of chapter 442, Public Laws of 1909, be amended by adding to said section the following:

That in the election of drainage commissioners by owners of land each owner of land shall be entitled to cast the number of votes equaling the number of acres of land owned by him and benefited as appears by the final report

of the viewers. Each landowner may vote for the names of three persons. Immediately after the election of said board of drainage commissioners, and after the members of said board shall be appointed by the clerk, the clerk of the court shall notify each of them in writing to appear at a certain time and place within the county and organize. The members of the board of drainage commissioners so elected and appointed shall serve for a term of four years, and to insure uniformity as to the expiration of their terms of service, their first term of office shall begin on the first day of August. In the year when their term shall expire the clerk of the court shall provide for an election in the manner hereinbefore provided, to be held on the second Monday in July preceding the expiration of their term. The clerk of the court shall keep a record in the drainage record of the date of election, the members elected, and of the beginning and expiration of their term of office. A like record shall be kept of any election to fill vacancies, and the members so elected shall only serve to the expiration of the term of his predecessor.

If for any reason the clerk of the court shall fail to provide for an election of drainage commissioners on the second Monday in July to succeed those whose terms will expire on the 31st day of the same month, the said clerk shall have authority thereafter to provide for such election, and until such election the incumbents shall continue to hold their office as commissioners until their successors are elected, appointed, and qualified. If a vacancy shall occur in the office of any commissioner by death, resignation, or otherwise, the remaining two members are authorized to discharge the necessary duties of the board until the vacancy shall be filled, and if the vacancy shall occur in the office of chairman or secretary, the remaining two members may elect a chairman or secretary to hold until the vacancy in the board shall be filled.

The term of office of all boards of drainage commissioners heretofore elected and appointed, or who may be hereafter elected prior to the second Monday in July, 1915, shall begin on the first day in August, 1915, and serve for four years from such date. Boards of drainage commissioners hereafter elected upon the establishment of drainage districts shall serve from the date of their appointment for four years from the first day of August succeeding their election.

The chairman of the board of drainage commissioners shall receive an annual compensation of seventy-five dollars (\$75) and actual and necessary expenses of travel and subsistence. The remaining two members of the board shall receive a compensation of three dollars (\$3) per day while necessarily engaged upon attendance upon meetings of the board or in the discharge of other necessary duties, and in addition their actual and necessary expenses in attending the meetings of the board. The secretary of the board, if other than a member of the board, shall receive such compensation for work actually performed as may be determined by the board. In drainage districts of unusually large area and requiring greater attention, the chairman of the board may be paid a greater compensation, to be allowed by the clerk of the Superior Court, provided the chairman, or the members of the board, shall file a petition with the clerk setting forth all the facts necessary for the determination of the matter.

SEC. 5. That section 25 of chapter 442 of the Public Laws of 1909, as amended by section 6 of chapter 67 of the Public Laws of 1911, be further amended by adding thereto the following:

That where any public canal established under the provisions of the general drainage law shall intersect any private road or cartway the actual cost of constructing a bridge across said canal at such intersection shall be paid for from the funds of the drainage district and constructed under the supervision of the board of drainage commissioners, but the said bridge shall thereafter be maintained by and at the expense of the owners of the land exercising the use and control of said private road; provided, if the said private road shall be converted into a public highway, the maintenance of said bridge shall devolve upon the board of commissioners of the county or by such other authority as by law shall be required to maintain public highways and bridges.

SEC. 6. That section one thousand seven hundred and ninety-two (1792) of the Revisal of North Carolina, which recites the classes of investments in which guardians, trustees, and others may invest their surplus funds shall be amended by adding after the words "North Carolina," in line five, the following words: "or in drainage bonds duly issued under the provisions of chapter 442 of the Public Laws of 1909"; and that said section shall be further amended by adding after the words "North Carolina" and before the words "shall be," in line eight, the following words: "and such drainage bonds."

That the State Treasurer is authorized to receive drainage bonds issued by drainage districts in North Carolina as deposits from banks, insurance companies, and other corporations required by law to make deposits with the State Treasurer: *Provided*, that the Attorney-General shall have approved the form of said bonds.

SEC. 7. That subdistricts may be formed by owners of land in main districts for the purpose of local or more minute drainage, in the manner provided in chapter 442, Public Laws of 1909, and acts amendatory thereto for the organization of main districts. Such subdistricts shall have the right to use the ditches or canals of the main districts for outlets. The formation of subdistricts shall not operate to release the lands in any subdistrict from the payment of any assessment or levy made prior to the formation of such subdistrict, nor from any assessment which may thereafter be made for the completion and maintenance of the canals in main districts, or for the payment of the principal and interest on any indebtedness incurred by the main district; nor shall it give the subdistrict any claim on the funds of such main district for its local use.

It shall be the duty of the drainage commissioners of the main district to control all matters pertaining to the main district drainage. Drainage commissioners for the subdistricts shall have authority and control over all matters pertaining to drainage within their respective subdistricts, except such work as belongs exclusively to the main district.

SEC. 8. The treasurer of the county and *ex officio* treasurer of the district shall deposit any surplus funds belonging to any drainage district in local banks in the county, and preferably in banks located nearest the said drainage district: *Provided*, the said treasurer shall be satisfied as to the solvency of such bank or banks, and, *Provided further*, that nothing contained in this section shall release the treasurer or the sureties on his bond from any loss accruing by reason of the insolvency of any bank or banks where such funds may be deposited. If the treasurer of the district shall deposit any funds belonging to the district in any bank he shall require the payment of the usual rate of interest paid by such bank upon time deposits.

SEC. 9. That section 12 of chapter 67 of the Public Laws of 1911 be amended by adding thereto the following:

That if, for any reason, the sheriff or tax collector shall fail to advertise and make sale of lands of delinquents on the first Monday of February or on the first Monday of March as above provided, then, and in such event, the said sheriff or tax collector shall advertise and make sale of any lands upon which the assessments shall remain unpaid on the first Monday in April succeeding, and if for any reason he shall fail to advertise and make sale on the first Monday in April, then he shall advertise and make sale of the lands of delinquents on the first Monday in May succeeding.

If any sheriff or tax collector shall fail to comply with the law for the collection of drainage assessments, as herein provided, he shall be guilty of a misdemeanor, and, upon conviction, shall be subject to a fine and imprisonment, in the discretion of the court, and he shall likewise be liable in a civil action for all damages which may accrue either to the board of drainage commissioners or the holder of said bonds, to either or both of which a right of action is given.

That in addition to the two copies of the assessment rolls as provided in the section to which this is amendatory, a third copy of the several assessment rolls shall be prepared and filed with the chairman of the board of drainage commissioners who shall carefully preserve the same.

SEC. 10. That this act shall be in force and effect from and after its ratification.

SUGGESTED AMENDMENT TO THE NORTH CAROLINA DRAINAGE LAW

By HARRY McMULLAN

1. Law should make clear whether when land sold it should be for the tax delinquent for the year *sold* and provide manner in which it shall thereafter be carried on tax books of district.

2. Law should be amended so as not to require interest on bond issue to be collected for a longer period of time prior to first assessment than necessary to pay interest that may accrue. There is a conflict in sec. 34 and sec. 35 as to three years interest to be added to bond issue which should be harmonized.

3. Law should provide for method of apportioning assessments on a tract of land which is subdivided after district is formed.

4. Time may be saved by eliminating the preliminary reports without injuring the interest of any party.

MR. JOHNSON: We have with us today, representatives of some of the banks and bond houses who have bought North Carolina Drainage Bonds, and we would like to hear from them.

MR. W. G. SCOTT of the New First National Bank of Columbus, Ohio:

Mr. Chairman and Gentlemen:—I sincerely regret I did not know that I was to be called upon for a talk, for you will mighty soon discover that I am not a public speaker, and I would like to have prepared something to say to you on the matter of drainage district bonds. I would like to correct one statement made by your good fellow citizens that I am manager of the

New First National Bank; I am merely manager of an adjunct of that institution, known as the Bond Department.

Your Secretary has mentioned a matter which I think is of very great importance to you good people of North Carolina. That is the matter of the security and the comparison of salability between drainage district bonds and general obligation bonds. I am afraid that a good many of you put the blame for the difference in salability upon the bankers and bond dealers. Now, in my opinion, that is not where it belongs. Very few of us buy these issues except where we expect to dispose of them—the ultimate arbiter in this matter is the individual purchaser. I am slightly familiar with the drainage laws and bonds of other states, and I know of no State in the Union where drainage district bonds sell on a parity with direct obligation securities. I think this is very largely brought about by the fact that the formation of drainage districts is a comparatively new thing; and another matter that I think tends to injure them, particularly in districts where drainage work is done in a large way, is the confusion in the public mind between drainage and irrigation. Now it may interest you gentlemen to know that, within the last—well, I will say the last three years, to be absolutely certain—we had occasion to take up with the *Manufacturers' Record* of Baltimore, Md., the fact that they were running their drainage and irrigation securities under the same caption. We took issue with them on that and, since it was brought to their attention, they have changed it. There have been so many frauds perpetrated under the name of irrigation that, while there have been a great many good irrigation projects, we, as an institution, have refused to handle any issues which had the name of "irrigation" attached to them.

There are two States in the Union with which I happen to be familiar, where the drainage work is done by the county, and the bonds become a direct obligation. While these issues have a ready sale, I am free to confess that, even in these States there is a differential between drainage bonds and bonds issued for other purposes. There is not a wide divergence in price, but there is at least a slight difference. In States issuing drainage district bonds—take, for instance, the States of Missouri, Arkansas, Mississippi, Louisiana, and even Texas—perhaps there is not a State in the Union that puts as great a safeguard around its drainage district laws as Texas. You are familiar with the decision of a few years ago, in which a Texas judge handed down a decision that, "In their essential elements drainage districts are no different from school districts." It seems that this is a point toward which you can well work in North Carolina. However, as, even in the State of Texas, drainage district bonds do not sell on a parity with general market issues, you will see that there is a good deal of missionary work and a great deal of constructive work to be done along these lines before you can ever hope to make your drainage district bonds command anywhere near the same price as general obligation issues. One thing that is rather hard for us, where our clients are not familiar with drainage, is the fact that drainage is really reclamation. When you take land that has an exceedingly small commercial value and put a considerable expense into your drainage (it is really reclamation, and that is what they call it in Louisiana) you have put a very heavy bonded indebtedness, in proportion to your assessed valuation. Now you can talk yourselves black in the face about the land values, but when you come to sell these bonds you cannot get people away from the

per cent of bonded indebtedness to the assessed valuation. You can tell about the wonderful value of these lands when reclaimed, but investors will usually come back to the point of beginning, which is a comparison of the bonded indebtedness and actual assessed valuation of the district. I have wondered, many times, if your law permitting the payment of the first three years of interest out of the proceeds of the bond sale, was not a detriment rather than a benefit to your drainage projects. It strikes me that it tends to keep your assessed valuation very low instead of bringing it up to somewhere near the actual value of the lands after the drainage is completed.

My good friend Mr. Small has sent me pictures of some of your wonderful crops here, and I have used them time and time again, but it frequently does not make any change in the attitude of the bond buyer. Only a few weeks ago I was showing these pictures to a prospective customer and he said, "O yes, I know all about North Carolina; the corn looks fine and is growing to a great height, but there are no ears on the stalks." What are you going to do about it? I mean from my point of view. And that is one of the things we are up against, gentlemen.

There is one thing that I think you can do in a definite, tangible way that will be of great benefit to North Carolina drainage district bonds. Now I am not an attorney and only reflect that with which I come in contact and that which I gather, but it seems to me that your laws regulating the drainage districts are too cumbersome. I used the word "cumbersome" as expressed by one of the most widely known firms of bond attorneys in the United States, who stated that on account of the North Carolina drainage law being so "cumbersome" they would not approve a transcript for less than \$250. Take an issue of \$10,000, for instance, and this is 2½ per cent before you are able to do a thing, and is a pretty fair profit for the handling of bonds. We submitted a transcript of a North Carolina drainage district issue to another attorney of national reputation, and he turned it down so cold it made me shiver. I do not know the particulars of your laws, but the Hon. Mr. Small has stated that your drainage acts were, in his opinion, the best that could be done under the existing statutes and, the fact that they have been sustained by your courts shows that they were carefully drawn. I am not here to attempt to tell you how to remedy this, and I assure you, gentlemen, that I am not saying these things to criticize but to bring to you some of the facts with which I have come in contact in a personal way. I was born and raised on a farm; have always been interested in farming, and drainage work interests me tremendously. I think you have wonderful possibilities here in Eastern North Carolina, and am very anxious indeed to see you put your drainage district securities in a position to command a better price. This, of course, will take time and some very careful legislation, but it is certainly possible. As conditions are at present, your bonds are retailed very largely on the strength of the bank or bond house which makes the offering and recommends the securities.

I am, perhaps, more familiar with drainage work in Louisiana than in any other State, because I come more closely in contact with it, and I am mighty glad that I have had the pleasure of coming down here and looking over some of the districts whose bonds our institution has handled, and of course, I am interested in the Lake Mattamuskeet District. This is generally considered a wonderful proposition, and I am exceedingly glad that we are to have an opportunity of inspecting this work tomorrow.

There is one phase of the drainage situation which I mention as a closing thought: that is, do not form drainage districts and put in drainage work more rapidly than you are able to sell the lands of the districts to actual farmers who will cultivate the lands, make the districts productive, and pay taxes from which principal and interest of your drainage district bonds are paid at maturity. There is perhaps nothing more desolate than a drainage district where the work has been completed and the land has not been put in cultivation. The ditches will, of course, deteriorate rapidly under such conditions and weeds will grow to the detriment of the land where productive crops should be raised. I believe you will always find it easier to sell the land of a new district rather than an old one which has been allowed to stand for a few years uncultivated. Not only does this uncultivated territory jeopardize the security of your bond issue, but it also entails an additional expense to the farmer who must clear out the ditches and do over again much of this work, to a greater or less extent, before he can put the land under cultivation. In this matter I am considering this phase of the question, not only from a bond point of view, but also from the standpoint of those who form drainage districts with the expectation of selling out their lands to farmers.

To you good gentlemen who have been reclaiming the wet lands of North Carolina, I wish to express sincere appreciation of your work; and surely there are few better things than the constructive work of turning waste land into very great productiveness and of permanently improving your part of the country.

I think we are all very deeply indebted to Dr. Pratt for the splendid work he has done in connection with the North Carolina Drainage Association, and to the Hon. Mr. Small for the great amount of time and enthusiasm he has put into the matter of your drainage laws. We perhaps take for granted, without due appreciation, the time and energy that these and other gentlemen have put into this work, particularly during the early formative period. May they live long, prosper, and continue their efforts for years to come.

MR. STUBBS: I am such a small banker I feel a delicacy in even expressing a thought. There are two or three suggestions that come to my mind in regard to this matter. I intended to ask Mr. Scott some questions while he was speaking. One question I would like to ask is what effect there is on the bonds if they are paid serially.

MR. SCOTT: I prefer the serial maturity. This obviates the sinking fund necessary in bonds of one maturity and is more economic for the district.

MR. STUBBS: I have had considerable correspondence in regard to the sale of these bonds. If anything could be done to make the organization more simple it would help it wonderfully. I find that even the failure to post some little notice or the smallest proceeding left out will make void a whole bond issue. In the sale of one of the issues of Pungo River bonds, it looked at one time as if the failure to find one copy of the newspaper would make it impossible to sell the bonds. That is one of the principal things that has come under my observation—the time it

takes to organize and the wonderful amount of papers it is necessary to produce in order to make a bond legal. As Mr. Scott says, it is impossible to get a bond attorney to pass on a bond paper except for a very large fee. If it is possible to amend the law in this way, I believe it would help matters considerably. Some houses object to the bonds being serial; they are ultimately placed in the hands of guardians, insurance companies, etc., who prefer their being made payable at a stipulated time instead of in small annual payments.

MR. PRATT: One question I would like to ask Mr. Scott. Ever since we have started the drainage work we have been trying to have the districts as they were organized, instead of being named after some creek or swamp, to be named after the county, as Mecklenburg Drainage District No. 1, Mecklenburg Drainage District No. 2, etc., and I want to ask Mr. Scott whether in his opinion it would not have some effect upon the sale of the bonds to have the districts so named. Suppose a bank had two issues of bonds from a certain county and had a purchaser to come in and buy bonds. Would he not prefer to pay for a bond named Mecklenburg Drainage District No. 1, to Flea Hill Drainage District?

MR. SCOTT: Yes, I think he would, decidedly.

MR. PRATT: I have always thought this and have mentioned it before at the Drainage Conventions. You will note that on this list we have Cabarrus County Drainage Districts Nos. 1, 2, 3, and 4. You will also note that we have Mecklenburg Drainage Districts Nos. 1, 2, 3, and 4, etc. Now, in other places we have a Flea Hill Drainage District, and the Bear Swamp Drainage District, and Buffalo Creek Drainage District. It always seemed to me that if we had two districts and two sets of bonds, and that if I were going to buy them, I would much prefer them to have the name of the county on them.

One other thing I wanted to mention in connection with that, and it is well illustrated in something that happened in Guilford County, and that is, assessed valuation. At the time that Guilford County took up the question of issuing bonds for the construction of public roads they found, as I understand, considerable difficulty in selling the \$300,000 bond issue. The bond buyers came and looked over the county, and they said, "You have not got enough to represent that bond issue. Look at your assessed valuation." The Guilford people said, "We can remedy that," and they went out and put the property considerably higher than before. It was not because they did not have the property—it was because they had assessed it too low.

MR. SCOTT: May I make one suggestion? I rather suspect that one thing which brings that condition about in North Carolina is the fact

that the first three years interest is payable out of the bond sale. If you, as in other States, compel the payment of interest at least by direct taxation during the first three or five years, it might be well. For instance, in Louisiana their bonds must begin maturity in five years. The series can run as long as forty, but the interest is paid by the landowners through a tax. I have wondered if your method has not kept the assessed valuation lower than it ought to be.

MR. PRATT: There is no question but that in any investigation of the land values in North Carolina there is a great big difference in what we say they are worth when we want to sell a bond and what we say they are worth on the tax books. Now, there are two or three sets of people who watch that very closely. If you go to the bank to borrow money, the bank will not take your word for what it is worth. Also, the man who is buying bonds takes a similar view, and also the man who is insuring your property. There is no question to my mind but that if we had our lands assessed at the rate somewhere near their real value it would be a help in selling our bonds the way the land represents the collateral for these bonds. Of course, we have got to keep in mind the results of the improvement to the land. In the beginning this land itself represents the collateral, and that is what the bond dealer looks into as the collateral back of his bonds.

MR. JOHNSON: I just want to emphasize one statement that Dr. Pratt made. In what experience I have had in attempting to sell bonds and in the formation of drainage districts, I have learned by bitter experience that it is not a good plan to try to go too fast; and I fear that proposition is the greatest trouble we have had in selling bonds in North Carolina, which has arisen from the fact that we were not as careful as we should have been. These good people who were charged with the formation of these districts have not adhered as closely to the extreme letter of the law as they should have, and for that reason we have found difficulty in making a sale. I think the most common mistake we make lies in the fact that our land titles are so incomplete in a great many instances that we fail to locate the actual owner of the land, and after we have proceeded for some length of time we finally discover that land was held perhaps by some tenants in common or minor heirs. Then we have to go back and start again; and I believe that in forming these districts in the very beginning we should endeavor to determine the actual owner of every piece of land in that district, make a proper list and find out if there is more than one claimant to one piece of land, and, if so, require that they come before the clerk of the court in answer

to this complaint. If we do this I feel sure we will facilitate the sale of bonds as much as any way we could devise.

MR. C. VAN LEUVEN: The law as it now stands requires that the bonds should mature serially, one-tenth of the whole amount being returned annually. In the case of most districts, especially small ones, this requires that bonds should be issued in \$500 denominations, and in most cases in \$100 denominations. Bonds of small denominations are not readily salable in this class of securities, and they are troublesome and inconvenient for the bond dealer and for the investor. I believe the facts will bear out the statement that "Baby Bonds" in \$100 denominations are purchased by a class of people who want investments in large and well known bond issues, which are listed on the exchanges, and that the class of investors who buy drainage bonds are usually people of more ample means, who do not wish their investments cut up in pieces smaller than \$1,000.

As the Board of Drainage Commissioners own or represent the owners of the greater part of the property in the district, it would seem that no risk would be involved in having the law so worded as to give the Board of Commissioners more discretion in the matter of issuing the bonds. If they do this, they can, even in the case of a small district, having a bond issue of say \$7,500, by a slight change in the maturities, so that it would not be necessary for exactly one-tenth to mature annually, arrange so that no bonds smaller than \$500 would need to be issued. It would seem reasonable also to give the Board of Drainage Commissioners more latitude in the matter of selling bonds, as it may be safely assumed that they will obtain for them the best price possible, whereas under the existing law which requires that the bonds be 6 per cent bonds, and sold at no less than par, it is invariably necessary for the Board of Drainage Commissioners to resort to a subterfuge, in order to get the bonds sold off.

MR. JOHNSON: I would like to ask Mr. Scott one question relative to the collection of the tax. Can you tell me when one man sells a piece of land that has already been listed in his name to another man who is not in the district and who has heretofore had no interest in it, what form of machinery these other laws have to change that assessment so that it will be charged to the ultimate purchaser?

MR. SCOTT: I do not believe I could answer your question in detail. I should think it would have to go through by the same process as the change of the general tax fund.

MR. JOHNSON: In our State we list our taxes once a year. In our Drainage Law the entire taxes are listed for ten years, and so far we have not devised any machinery for changing that list.

DRAINAGE CONTRACTORS

By M. W. THOMPSON of Greensboro

I wish to state that I certainly appreciate your giving the contractors a special place on the program. You usually look at a contractor as a one-sided individual, looking after his own interest entirely; but I have always taken an active interest in connection with every progressive movement in my community, and if I can say anything or do anything to help along the cause of drainage I wish to do so. I have been attending the conventions for the last three years and I have been greatly interested in the work, and there is one phase of the drainage work that has always impressed me: that is the need of better financing.

At the first convention I tried to make a talk on "Drainage Bonds." As soon as I became interested in drainage work I was met with the question of financing the districts; in fact, none of the drainage districts, except two, that we have constructed have been able to finance themselves without calling on the contractor to assist them.

There has never been a district in this State, so far as I know, which has been able to sell its bonds at par, and the law states that the bonds must be sold at par. Now when a district gets to that point of either breaking the law or attempting some subterfuge to get around that particular point in the law, I think it would be well for us to devise some change in the law. I asked the representative of the New First National Bank yesterday if he ever knew of any drainage districts whose bonds at 6 per cent had sold for par, and he stated he did not. I think there should be some change in the law to reduce the embarrassment of the commissioners, if nothing else. I have never given much consideration to the general phases of the law until just a short time ago when I had a letter from an attorney, who is considered the highest authority on drainage law in the country, informing me that he would not consider any more North Carolina drainage issues; that so many difficulties appear on the record it is practically impossible to examine a North Carolina drainage issue without being actually on the ground. Shortly after receiving that letter I started in to see what some of the other states are doing and I find that the Western States have laws which I consider quite superior to the North Carolina law. We could not wonder at that very much, for they have been in drainage work much longer than North Carolina, and Illinois has been doing drainage work for about thirty years. They have met many of the difficulties we are now experiencing and have reached the point where they can proceed much faster than we can here.

Dr. Pratt has referred to the list of forms which have been of immense help to the districts in this State in organizing under our law. I find that in some of the Western States they can actually organize and elect commissioners by going through about four forms. They are organized in a much clearer way, and the securities command a much better price on the market.

I find that this matter of a good drainage law has been taken up in a very complete form by the National Drainage Congress of 1912. They appointed a committee of men of national repute, engineers and attorneys who were familiar with drainage work. They gave a great deal of time and thought to the matter, and the result of their deliberation was the "Model Drainage Law." I have a copy of that law here, and it is far ahead of what we have here in North Carolina in point of simplicity. Under this form the small

landowner is taken better care of and more fairness is shown to the man who objects to the formation of a district; and districts would meet with less opposition, I am sure, as the hearing on the petition and decision is given by the court, not by the clerk, as under our present law. Commissioners are elected at once upon the decision to establish a district, and not after several hearings before a clerk on the details of the plan of construction. All notices are served by publication. More definiteness is given to the collection of the tax and the few forms necessary are made part of the law.

The Model Law has had its provisions passed upon by the Supreme Court judges in the Western States, and the National Drainage Congress recommends it to the Legislatures of the different States. I have not gone through it very thoroughly, but I know in the matter of the formation of the districts, where we have so many provisions to carry out, that it is far superior.

Take the history of our drainage districts: you will find in the list we have here a number that have never reached the point of electing commissioners, and a great many that have never been completed. I think that those who had charge of framing our original law have done admirably. They have furnished the machinery by which a great many districts have been organized, and this State has taken the lead among the Atlantic States to such an extent that they have all copied the North Carolina law, with the exception of Florida; but in the construction of anything as we go along from year to year we gain experience, and I think now, in considering changes to the North Carolina law, that we should give a study to the changes that have been made by States that have been engaged in drainage longer than we have here and take from their experience what would be of material advantage to us.

MR. JOHNSON: We have with us today Mr. E. E. Schooley, representing The A. V. Wills & Sons of St. Louis. Mr. Schooley is in charge of the Lake Mattamuskeet drainage project in Hyde County, the largest drainage project undertaken in North Carolina, and one which is unique in the South.

MR. SCHOOLEY:

Gentlemen of the Convention:—I do not know that I am able to say a great deal, as I have done but very little. I have reorganized out of an old organization a bunch of men who have brought about the excavation of over 300,000,000 yards since the first of March, 1915. We have not completed the work, but we have nearly completed it. We had some maps that I figured on getting on the wall before the Convention started this morning, but, due to the fact that I had to get some grub out to the boys, I did not get around to it.

I find one of the essential things with the contractor is the price. The next thing is the organization. You cannot have one without the other. The third essential thing is first-class machinery. You cannot go out in the woods here and pick up scattered men or any old common ordinary man to work on a dredge. The kind of man that you need I will illustrate with one of mine. His name is Ross and he comes from Indiana. He went on a two-yard machine in the lake a year ago the first of last November. He has never left since that day. I do not suppose that that man has drunk a thimble

full of intoxicant. He is always there and is a real healthy man and gets along well with the other men. You can figure when that man goes out in the morning that he is going to do a day's work. He is going to look after the company's interest because he feels like it. These men are just as much disappointed by not getting a good result as the contractor himself. This man makes it easy for the superintendent and makes a success for the contractor. Another thing that makes it nice for the contractor is to have the coöperation and good feeling of every one in the district. That is another very essential thing, because we are having some little trouble out there now—not very much, however. There are very few people who live in a place like Mattamuskeet Lake, or that live in a place where there is very little drainage carried on, that can realize what a dredge ditch is going to be. When you talk about putting a dredge through your farm, they have an idea that it is going to be a ditch about so wide. When you get in there with your right of way and take a couple of hundred feet wide, that is a different proposition. I believe a good suggestion would be in framing the drainage laws of this State, for the Board of Viewers to estimate the damage that is going to be done where the ditch is going through and pay those men outright for this land; and the feeling against the contractor will be eliminated and a great many times this will eliminate hard feelings between neighbors when they get the coöperation of every one in the district. We had our proposition at one time held up by such a condition. One time we had our foreman ordered off, and we have had lawsuits. The people would go out and curse the men, and they would do everything they could to stop the work and to delay it. We do not have the hearty coöperation of these people now that we had at another part of the district.

The contractor as a rule is one of the best organizers of drainage districts that you can get hold of. If any one wants to know anything about organizing a district the chances are that they will go to a contractor and not to a lawyer. I have had a dozen come to me, and on two occasions I have cited them to people, and the organization of the district has practically started through. When they come to me I generally tell them where to go to get lawyers, and I have been asked a great many different questions and helped start things going as well as I could. I am not familiar with drainage laws, but any one interested in drainage work from the contractor's standpoint will usually keep looking around and proposing this and that, and saying to such and such a fellow what kind of district he should get. He will say, "Well, we have a lot of swamp," and I will say, "Why don't you have it drained?" They will begin to question you about it and talk about it. We like to see these organizations start up. The more we get started the better off we are. The one thing we do want and must have is the price. I think that in the work of the contractor the responsibility or the possibility of a man's doing you a first-class job is one of the main considerations. Do not take altogether the man who says he will do the work for 6 cents per cubic yard. He will probably be the most expensive man you can have. You have to have equipment, and that costs money. You can figure almost always in putting a new machine on almost every job you go on of any consequence. We have four machines on this job out here now. They were all practically new, and we have had some trials and troubles and tribulations as most every contractor will have, but we get a fairly good price and we are going to make some money. That is what we came down here for. We are not

going to make the money here that we figured on. We never do. We have had exceptionally good people on the engineering work here—what I mean by that is, they do not expect impossibilities. We had a fair price here, and I am willing to say this, that there is not any of that ditch dug but what has been dug from one to four feet. If we get the price we can afford to do it right, and we cannot afford to do it in any other way because we have a reputation to maintain in doing first-class work, and we do it.

One of the main things, I think, for the engineers who lay out the districts and the commissioners, and particularly the viewers who get the money for the district, to bear in mind, is that to get good work done you have to pay a good price, and you should have a little money on the side. It don't hurt anything for you to have \$300 or \$400 left when your ditch is finished, because there is nothing undertaken or done but, if it were done again, it could be done to better advantage. Frequently it is better to have the ditch deeper or longer, and if you have the appropriation to do it while the machines are there it can be done to much better advantage than it could at any other time.

I would like to see tile drainage started in here. I have done considerable tile drainage in my time in drainage work, and I have put in some 3-inch drain tile. I presume that I was raised in one of the oldest drainage districts in the United States. Twenty-eight years ago they dug a dredge ditch down what is called Lake Fork, in Illinois, and my father owned a farm in that drainage district and I know something about the kicking against the organization of that drainage district when it began. At that time the lands were worth about \$8 per acre—about eight months ago I refused \$200 per acre for that land. Last year I made 65 bushels of corn to the acre on that land. To give you an idea of how the laws are there, to a certain extent the whole district is under the head of three commissioners, and then each lateral that comes out from the main ditch is a small district in itself. Some people do not care to be under the head of the lateral district. They had an idea that every time a commissioner lets a contract the contractor would make \$10,000 or \$15,000, which is not often the case. My father and some other men in that section formed their own drainage district, dug their own ditch, and maintained it for about twenty-five years. When I got hold of the farm I wanted the tile drain through there. It got to be that every fall you had to pay somebody \$5 or \$10 to clean out the ditch. I went around among the gentlemen who owned land and asked them if they would agree to the tile. Every one in that small drainage area opposed tile drainage because it was going to cost money. I went to the commissioners and told them that I wanted an outlet through that place. It was a waste of land and time to have the open ditch through there, and I convinced them that I was right. We went ahead and took charge of that district and put in tile and increased the price of my land \$25 per acre. We paid a tax on it for maintenance, and now have one of the best drained farm lands in that district.

I would like to see the Drainage Law changed so that the contractor can, when it is desired, take bonds for work at a fair price. I believe it would help you a whole lot in getting your districts through and would be a mighty good thing. I had a proposition some time ago, and I was somewhat unacquainted with that part of the law, so in forming our bid it seemed to me a two-way proposition; it was either a cash proposition or bonds for the work. I told them I would take the bonds and do the work at such a price. My

proposition was to take cash or bonds at 95 cents for the work. That eliminates a lot of work of selling the bonds, because the contractor can sell the bonds if he has many of them to sell, just as well as an attorney who never sold them before, and a great many times the contractor can go through the proceedings and tell you whether the attorneys are going to pass on them or not, and a number of the lawyers cannot because they have not had that experience. I did know of a contract that had to be let a second time in this State because some of the proceedings were not right.

We have a nice little job in Florida, and if you fellows at the convention would come down and see us in Florida we have something there that I think would be of interest to the people of North Carolina as long as they are going to maintain the open ditch proposition. We have a ditch that is four feet wide in the bottom and five feet wide at the top, with a depth of approximately four feet. In regard to the labor, it has got mighty scarce down there. Most of the white men hate to handle the shovel, and the proposition now is to get labor to handle the work. I think we are going to find out by trying different projects on it, and we may not get anything out of it finally, but we are going to get a whole lot of experience. If it will be of any benefit to anybody up here I will try to give some dope on it.

RAILROADS' INTEREST IN THE RECLAMATION OF SWAMP LANDS

MR. JOHNSON: In this connection I want to say that while we have done what we could as individuals and districts for this drainage proposition, we are free to admit that but for the railroads all of this work would come to naught; and it is only fair to the railroads to state that they have heartily coöperated with us in our efforts to reclaim this country, and they have rendered us a very great service in advertising our work and the value of our lands.

We have with us this morning a gentleman who, while he is not just exactly a railroad man, is president of a company which is so closely identified with a railroad that it is pretty hard to tell one from the other. I refer to Mr. C. I. Millard, president of the John L. Roper Lumber Company, and an interested party in the Norfolk Southern Railway Company by virtue of that fact.

We shall be pleased to hear from Mr. Millard.

MR. C. I. MILLARD, of the John L. Roper Lumber Company of Norfolk, Va.:

Mr. Chairman and Gentlemen:—The introduction was not exactly correct. I have nothing to do with the railroads. Drainage is of great importance to the railroad companies, the barge companies, and all who do their business through the canals. Every city whose people have business in these lands, and whose traveling men come into this country to secure orders, benefit by the drainage improvements.

I have received the impression this morning, as I have heard these gentlemen speak, that there was running through the meeting a note of pessimism about the difficulties and troubles connected with the Drainage Law. There is nothing impossible, and nothing worth while can be won without a fight.

There is no trouble about the law which cannot be overcome. When the people understand it, and have the proceedings carefully gone over, the bonds can be sold. They are much better than irrigation bonds, because every irrigation project has been more or less a failure, as they have had to tile-drain their lands at a tremendous cost of \$40 to \$60 per acre. Our lands do not require anything of that sort. Neither do we have the difficulties of climate that are encountered where an irrigation scheme is necessary and where the evaporation is so tremendous that the amount of land which has to be irrigated cannot have a very large area, inasmuch as it requires so much water to meet the demands of the crop. The lands here are rich; every one knows that; and the only thing to be done is to take the water off. The only way to take the water off is to drain it, and the only way to drain it is to form a district. The only way to form a district is to go to work!

MR. G. A. CARDWELL, Agricultural and Immigration Agent of the Atlantic Coast Line Railroad:

Mr. Chairman and Gentlemen of the Convention:—Dr. Pratt has invited me to make a short talk in regard to benefits of drainage from the standpoint of the railroads. In this matter I am unable to separate the interests of the railroads from those of the public at large. The railroads will obtain and enjoy no advantages from drainage that will not accrue to the public. These advantages are numerous and well known, and it is not, therefore, necessary for me to deal with them at this time.

Railroads furnish means of transportation for persons and goods from place to place. They have only one source of revenue, i. e., the sale of transportation.

Touching briefly upon the history of the American railroads: the progressive achievement of the American railroads is the greatest achievement in the world's history. There has been concurrent with it a similar achievement in all branches of industry and general development wherever the railroads have reached. Notwithstanding the fact that for more than four hundred years we reveled in a wealth of natural resources, our agricultural lands, mineral beds, and forests were practically untouched before the advent of the railroad. The first exhaust of a locomotive in this country in August, 1829, ushered in a new era, opened up new opportunities, which grew apace as the means of transportation grew.

Railroads cannot live without traffic; hence, in addition to solicitation departments for the securing of competitive traffic, almost all of the larger lines maintain departments for the encouragement of agriculture, industry, and immigration—in other words, for country building.

The future development of Eastern North Carolina depends largely upon the reclamation of our wet lands and the stumping of our cutover lands. One of the scientists in the Soil Survey of the United States Department of Agriculture, in discussing the truck soils of the Atlantic Coast region, tells us that not 10 per cent of Portsmouth soils (the Portsmouth series usually occupy depressions in the upland portions of the territory along the immediate coast line, and for a distance of approximately fifty miles inland) has been reclaimed and used for agricultural purposes. The usable area of the soils of this series is therefore very great, and the crops which may be grown depend rather upon the adequacy of drainage than upon any other factor aside from transportation facilities. Our great need is more people of an

agricultural type. A systematic immigration campaign is being conducted by the railroads, but we cannot settle people upon wet lands; therefore not only the railroads but all branches of society are vitally interested in drainage.

Bacon says, "There be three things which make a nation great and prosperous: a fertile soil, busy workshops, and easy conveyance of man and goods from place to place." A kind Providence has provided North Carolina with a fertile soil (when properly drained); enterprising business men have established the workshops and factories; and the Atlantic Coast Line is an easy conveyance for man and goods from place to place.

MR. JOHNSON: Referring to Mr. Millard's note of pessimism, I want to say this. I am not sufficiently conversant with the Scriptures to quote verbatim, but I remember that Saint Paul says something like this: He says twice he has been beaten with stripes, and mentions quite a number of persecutions he has undergone, and finally he winds up by saying that after all, brethren, I reckon how the trials and tribulations of these times are hardly worth being compared with the glory that is to be revealed within us; and I think these remarks are peculiarly applicable to our condition. I know we have had a good deal of trouble and I believe our districts, especially the ones organized, have cost more money than they should; but however great the cost may have been, I am certain of the fact that it cannot begin to compare with the benefits we are daily deriving from them. Therefore, while we are together on this occasion and at this time seeking to pick whatever flaws we may in our Drainage Law, the object of this is to enable us to improve it in the future and to help the men who are just starting to steer clear of the difficulties we have encountered. After we leave this Convention, Mr. Millard, all of us are optimists when we speak of drainage in this community. We are only pessimists in this building.

It was announced with regret that Congressman Godwin was unable to attend the Convention.

MR. PRATT: There are a few words that the Secretary would like to say: that is to give the names of the two men I referred to last night as making inquiry for the drained lands. One is Mr. W. C. Moore of Statesville, who is asking for 1,000 acres of swamp land which has been or is about to be drained. The other is Mr. O. E. Schoonover of Charlotte, R. F. D. No. 1. He says, "I have lately moved here from the north and wish to secure a rich farm where I can buy it at first cost as I have sons who will help develop it. Of course, I want some hill land for building location for health's sake, and land, if not drained, that could be drained at not too great cost to me." I do not know what he wants except to get in touch with people down here who have the kind of land referred to, and any of you who want to make such a sale can write to Mr. Schoonover.

TUESDAY, NOVEMBER 30—Afternoon Session

MR. PRATT: We have received thus far invitations from the following cities to hold the 1916 Convention: Raleigh, Greensboro, Creswell, Goldsboro, and Charlotte. These names have been turned over to the Committee on Nominations and Next Meeting Place, and they will decide this matter.

MR. JOHNSON: I want to apologize to the Convention for being a little late. It is a pleasure to me to present our next speaker. Saving Dr. Pratt, I know of no man in North Carolina who has devoted so much time and such a great deal of thought to our Drainage Law as has Mr. Small. I have been associated with him in the formation of the Pantego Drainage District, which was the first district organized in this community. I have been impressed with the careful manner in which he worked out all of the difficulties which we encountered. Since that time I have been a member of two Legislative Committees in connection with Mr. Small. Last year I went to Raleigh and he came down from Washington City, and with Dr. Pratt we spent a day in studying the needed changes in our Drainage Law. After that I came back to Mr. Small's office in Washington, and we spent another day, after which Mr. Small spent, I never will know how much time working on this law. Finally he drafted what I considered a very good Drainage Law, and that draft was submitted to our last General Assembly. For some reason, I never have known why, these amendments were not adopted; and in this connection I want to say that I believe it should be the first duty of every delegate who attends this Convention to impress upon his representative, whether in the Senate or the House, the necessity for adopting the changes which this Association shall recommend to the next General Assembly. I believe that we are in a measure to blame for not securing the legislation that we so much desired. We spent enough time in working out the details and preparing these various amendments, but when it came to securing their adoption on the floor, I believe in a measure our Legislative Committee fell down. Since the bulk of this drainage work is being done or undertaken in eastern North Carolina, I am persuaded that the representatives from the central and western portions of the State have not a definite idea of the great necessity for these needed changes, and inasmuch as we inspire in the hearts of our representatives from these eastern districts no strong desire to aid us in this work, we cannot hope for the coöperation of these western people. Twice I have been to Raleigh in this connection, and I have discussed this matter with a number of representatives, and have become fully convinced that they did

not understand our problems, and that we need some one there during the entire session who is sufficiently conversant with our conditions to protect us. It is apparent that the lack of such a person in our last General Assembly was fateful to our hopes. We are exceedingly fortunate in that in our Congressman from this district we have such an ardent disciple of drainage. We have a man who, to my certain knowledge, has given this matter a lot of study, a man who has devoted quite a lot of his valuable time to this question. I therefore take great pleasure in presenting as our next speaker the Honorable John H. Small, Congressman from the First District, and I know that all of you who hear him will be both entertained and instructed.

ADDRESS OF HONORABLE JOHN H. SMALL

Mr. President and Gentlemen:—I am grateful to the President for the gracious manner in which he has presented me to you—not that all his compliments are true, but nevertheless that does not diminish the appreciation. I have taken leave of a very busy period to join with you in attendance upon the annual meeting of the North Carolina Drainage Association. Among the many activities of our people at various times leading to different, and yet, let us hope, altogether beneficent results, there is a distinct pleasure always in cooperating with men and women who are engaged in work of a constructive nature. It is so easy to pull down; there is so little virtue in criticizing. We are inclined more or less to minimize public work which is being done either individually or collectively, and the most difficult of all work is that which organizes and builds up and makes ready for the doing of things for the common welfare. Unfortunately men like you who attempt to do things are criticized because the critic is always with us, and perhaps serves a good purpose. You cannot engage in any work which brings you into contact with others and requires you to join with others in doing things, without running counter to the opinions of some one and without being in the way of some one. That seems to be an inevitable law of progress; and yet if there were not men and women who had the faculty of initiative and who were resourceful in providing ways and means for giving force and effect to their initiative the world would stagnate, its industries would dwindle, and the march of progress would cease. This organization stands for one of the constructive measures of great moment to North Carolina. It involves more than the taking of the lands which the God of nature has presented to us, and tickling them and getting crops; it requires that man himself shall do something preliminary in order to put these lands in condition for production, and in that it only typifies another law of life. Life for the individual is one of struggle, and the great Creator seems to have so arranged the material world as to fill it with difficulties in order to place its mysteries beyond the reach of the average man, so that they may be only unlocked by active mental processes, diligence, and industry. And it is true with the individual and with the community that where life is easy, where men are not prompted to diligent labor in order to unlock the mysteries of nature and utilize them, that man himself deteriorates and degenerates. If you want to see a man stand still, make life easy for him. It is a truism

that the boy reared in luxury and idleness never accomplishes anything in life; he is a nonentity. He is simply a neutral quantity cast among the flotsam and jetsam of life, doing nothing for himself or others, and there is added to that a life of unhappiness. So this law, teaching us that we must acquire habits of industry, that we must train our mentality, that we must struggle to bring things to pass, is necessary for human development and for material progress.

I was in a community in Eastern North Carolina not long ago, located on one of our beautiful waterways, and found a community which seemed to be dead. The stream abounded in fish, and all you had to do was to go out and catch them and bring them in for food. The land was fertile. It was evident to the most casual observer that all you had to do was to plant and reap; and yet I think it is about the deadest community in Eastern North Carolina. They had never had imposed upon them the necessity for labor, for indulging in strenuous mental processes in order to obtain a livelihood, and thereby acquire habits, both physical and mental, which would enable them to progress.

On the other hand, some of the most progressive communities in the United States are those to whom nature seems to have been most unkind. Less than a year ago I was in a little community in Massachusetts; there were rocks everywhere. The first duty required of the farmer was to spend weary days picking up the rocks and putting them in piles. Their coal for fuel and power was transported from distant States. There was absolutely nothing produced within miles of that section which could be manufactured, and yet I saw factories operated by water-power, electric power, and steam. I saw beautiful, attractive, happy homes; good roads, good streets, commodious churches and schools—all of the marks of a civilized community—and yet if any man had gone to this community in the first instance and thought he could live an idle, thriftless life, starvation would have soon confronted him. These two illustrate the proposition that man must have the impetus and the incentive of struggle for development, and Nature only yields her best when that kind of man gets behind Nature.

We have down here in Eastern North Carolina fertile lands. Everybody knows that. We have tested some of them. And yet there are hundreds of thousands of acres of these alluvial lands which have been cultivated for a hundred years or more, and today they are inefficiently drained. And the men whose vocations are on the farm, and who have made their homes on these lands, and they and their ancestors have cultivated them all these years, have looked forward with comparative certainty to the immediate future and have been able to say once every three, four, or five years that "excessive rains have drowned our crops," and they will repeat the old, old story, "We had good crops, but they are drowned out." And we have other hundreds of thousands of acres of land just as fertile, some of it more fertile, which during these hundred years we have permitted to remain unreclaimed. We didn't need it. We ought to have put in condition for crop production that which has already been reclaimed; but I take it that the time has now come when there is a demand for additional lands, and the problem which now confronts the owners of these lands and those who wish to purchase them is to drain them and put them in condition for tillage—fruitful, successful cultivation.

I went to my home a little early last night wondering what I could bring to you this evening that would be at all suggestive and practical. I am somewhat of a practical turn of mind myself and strive to give practical advice to others. When we realize certain material conditions should be improved, we cast around to see how it may best be brought about. I remember to have read in a certain paper an article signed "Farmer," opposing the issue of bonds for public roads, and I said that will be my text, and I will read it to you directly.

I was very much interested this morning to hear the discussion from experts in regard to the Drainage Law. It is cumbersome to a certain extent, and it is, to a certain extent, inefficient. Having had something to do with the drafting of the original law, I may say that at that time a difficult situation was presented. It was hard to draft a law which would be sustained by our courts and which would be adapted to legal conditions in North Carolina as they exist by statute and have been built up by our court of appeals. The numerous provisions for giving notice to landowners were predicated upon legal precedents established for many years in North Carolina, which throws around owners of property various and sundry kinds of protection. The fact that this law has in its entirety been sustained by the Supreme Court of North Carolina is evidence at least that it is legal. I think, however, that the time has come when we may properly redraft our law in its entirety, and I believe this Association can do nothing better at this meeting than to appoint a committee, which will work out and report to the next meeting a bill as a substitute for the present law; and if it should be adopted by the next General Assembly, it should simply provide that all drainage districts then existing should be controlled by the former law, and new ones fall under the new law. I think that would be more effective than any attempt to amend the present law. Numerous amendments might be joined with other features of the law; but I think, perhaps, some of the most necessary amendments are basic and involve a repeal of some of the essential features of the existing law. An attempt by the last Legislature to enact one amendment resulted in an error which has caused serious complications. I was very much impressed by the remarks of Mr. Scott, of the New First National Bank of Columbus, Ohio. I have known him for years, most favorably, and as an expert in his position as banker. I was impressed by his statement that bonds must be predicated upon their final purchase and ownership by the investor. I recall when the Pantego Drainage District, to which the President referred, sold its bonds. I venture to say that these bonds are now held by ten, fifteen, and maybe twenty different holders. They bought them from the bank, the original purchaser, and as Mr. Scott has said, the bank bought these bonds for the purpose of selling them. They don't hold the bonds which they purchase; they are simply dealers in bonds. They have a responsibility and represent a position of trust toward the purchasers of these bonds, because if they sold a bond about which there was any difficulty in collecting the interest, it would embarrass the representatives of the bank and render it difficult for them to sell bonds in the future. The bank itself depends upon the expert attorney who examines the bonds as to their legality, and gives his opinion thereon. This expert, and the bank in turn, look to the local attorney, to the drainage commissioners, and to their representatives in the sale of the bonds; and the landowners in the

respective drainage districts should appreciate the exceeding importance of the district being so established that there shall be not only no difficulty but no delay in the payment of the interest and also in the payment of the principal. If one district in Eastern North Carolina, we will say, should make default in the payment of its drainage bonds, it would impair the sale of drainage bonds all over North Carolina. You will hear dealers in bonds say, "We want no bonds from a certain section. We wish no irrigation bonds from a certain State." Because a drainage district of this section has defaulted in the payment of bonds, a distrust has permeated the minds of the buyers of such bonds and they don't want to buy any bonds from these particular States because they know these bonds are held in bad repute by investors. A bond has a reputation just as an individual has a reputation, a section, and a State. And just as every merchant and every business man and every farmer should strive to build up his reputation for fair dealing and honesty, so that his bond and his promise will be of equal value, so ought these public enterprises issuing bonds seek to build up their reputations.

I wish to speak to you about two obstacles to the successful prosecution of these drainage movements and the organization of drainage districts. There are two elements involved in every public activity, whether that activity be the building of schoolhouses, the levying of local school taxes, the issuing of bonds, and the levying of taxes for building good roads, or the organization of drainage districts. First there are the rank and file of those who are interested simply in their own lives and who have no time or inclination or talent for mastering the details of the proposition. All that they ask is that they have wise leadership and that they shall not be brought into any financial or property entanglements. Then there are the leaders of every movement which depends upon the rank and file of the men who engage in any public activity for improvement and progress. The rank and file ought to be intelligent; they ought to be progressive; they ought to have a disposition to coöperate; and they ought to have confidence in those who assume the leadership in the movement.

I said I had a clipping which gave me the text for one class, the rank and file in all these public movements. Here is a man who wrote a letter to a paper about a proposed bond issue for the building of public roads, and here is the argument which he gave against it:

"I don't see why the farmers of County want to vote for something to put more taxes on them, as there is already enough forced on them without voting for more. By the time a poor farmer pays his fertilizer bill and grocery bills and taxes he has not enough left to buy winter clothes for himself and his family. I don't blame the city man for wanting better roads. It will add more to his pleasure in riding seven days to the week with his wife in an automobile. They won't get jolted so bad on a smooth level road, and of course a little more taxes added on his list won't hurt him, as he is going to have his anyhow whether the farmer and his family get anything or not. Now the idea of a country farmer voting to pay more taxes to improve the county roads is ridiculous, as they are all right for him to haul what little produce he can raise to town, and they certainly are good enough to haul all that he is able to bring back from town."

That is a sample of some of the men in the rank and file who are asked to join hands with their neighbors and do something for public betterment. You all recognize the value of good roads. The statement has been expressed thousands of times that good highways are the best index of civilization; that they improve the value of our farm lands; that they make for better schools; that they augment attendance upon our churches and increase their membership; that they enable our people to associate more freely one with another and extend the radius of their travel and intercourse; and that no community or county or State has ever built good roads who doubted their value or the profit in the investment; and yet you have heard what one of our farmer friends said about it. I say that the man in the rank and file who is asked to join in this public movement where coöperation and unity are necessary ought to have intelligence, progressiveness, the disposition to coöperate; and he ought to have confidence. He ought to have intelligence, because that lies at the very beginning of every progressive movement; ignorance begets prejudice, narrowness, and a disposition to harp and criticize. He ought to have progressiveness, because a man who has reached that stage in life and does not look forward to something better, who does not hope that tomorrow, next week, and next year will usher him into a better condition than the present, who is not filled with the inspiration of hope and who is not willing to strive to convert that inspiration into reality—you cannot do much with that sort of man. He is willing to remain in the rut where he has gradually placed himself, and I sometimes think, if it would not be sacrilege to say so, that even the grace of God could not pull him out, because God is not willing to do anything for a man who is not willing to help himself.

He ought to have confidence. This world is built upon confidence. You and I and everybody have dealings with men every day who make a promise to us, direct or implied, and we rely upon it. I have to travel a good deal upon some of the railroads, and whenever I can, in order to save time, I go on the sleeper. I go to bed and sleep with absolute confidence that there is an engineer at the throttle who will conscientiously do his duty to save the train and the lives of his passengers. We do not go through a day, no matter how narrow and restricted our lives may be, that is not actually based upon confidence. Recently a gentleman who happened to live in New York said to me, "There are millions of dollars every day of transactions in this city which are based simply upon faith of man in man," and yet you and I go among our people, and when some proposition is submitted, maybe for local tax for schools, maybe a tax to get revenue to build a schoolhouse, maybe a tax for public roads or bonds for public roads, some proposition to join hands in the organization of a drainage district, and we appeal to a man and tell him about the benefits that will ensue, and what is the first thing that we hear? "Oh, John Smith or Bill Jones, they have some scheme they want to make some money out of." If it is a drainage district, it is some plan to put so much taxes on my land that I will have to give it up. Lack of confidence; confidence in no one! And it even enters the sacred precincts of the churches. You will find a man enrolled in that sacred cause and, when the church wants to engage in some activity, he will be impugning the motives of other good men. So all these public movements must excite among the rank and file of those who make up the great majority a feeling of confidence in the men who lead and who are actively behind the movement.

There is another obstacle, and that rests in the leadership of these movements. It is not a one-sided affair. There is some ground for criticism occasionally of the men who assume the leadership. There are men who seek to be the leaders in many of these public movements who are actuated by selfish motives and purposes; and while we may criticize the ignorant and those lacking in progressiveness and mutual confidence among the rank and file, there are no words of criticism too strong to apply to him who assumes to lead the people in any public movement, and yet is actuated by selfish and unholy motives. "For unto whomsoever much is given, of him shall be much required; and to whom men have committed much, of him they will ask the more."

The men in the community, the men in the county, the men in the State, who by inheritance and training and by travel and reading and study are the more intelligent, who have been able to acquire something of a competence in the way of property, who are looked up to as leaders in their respective communities, they are those who are referred to in the quotation given and from whom much shall be required. Upon too many occasions in North Carolina, when public movements have been initiated along all these lines, which make for public betterment, there have been found men who have forfeited the confidence which has been placed in them and who have sought to utilize that confidence by coining it into personal profit at the expense of the body of men who are reposing confidence in them. It is hard to build up a reputation for integrity and confidence. It takes days and weeks, and sometimes years, while it may be shattered in a day; and one, two, or three men who are participating in a movement and permit themselves to be actuated by selfish motives of aggrandizement at the expense of their neighbors, who repose confidence in them, will destroy for a whole county or even a larger area the confidence of the people in public leadership and make it more difficult in the future to organize any of these public movements.

Gentlemen, in this movement for drainage we can find lawyers of integrity and character and capacity to represent us in the formation of drainage districts; we can find competent, skilled engineers to make the surveys and the plans and the estimates; we can find banks who will buy the bonds in normal times if they are predicated upon proper security; but there are these essentials without which drainage districts cannot be established, and that is that you must have in these communities and in your drainage districts landowners who are men of intelligence, men of progressive spirit, men who have confidence in each other; and you must have leaders who are entitled to the confidence of the landowners who are invited to participate. Without these essentials this great movement will not progress as it ought to progress. Now I know that all this may sound prosaic and you will all say, "Yes, we know this"; and yet, if it is true that the success of this movement is predicated upon it, then we cannot represent it too often and endeavor to find the remedy. We have a great democracy in North Carolina, a great democracy in this republic of ours. No man can be an aristocrat and say what shall be done; no man can order public roads to be built, drainage districts to be established, schoolhouses to be constructed; no man can say that this community shall have the essentials which are necessary to a high degree of civilization. All that can be done is to furnish the law, the machinery, the method by which it may be accomplished; but its success depends upon the

folk in the community, in the county, in the State. We have inaugurated a great movement. I hope the annual conventions of the North Carolina Drainage Association will continue. I see familiar faces here who have attended other conventions. I hope they will continue to attend, and that they will bring other friends who will go into the various sections of North Carolina and preach the doctrine of drainage until this movement, which means so much to our welfare and the promotion of what after all is the greatest industry in the State, that of agriculture, will grow and increase until all of these lands, so fertile and yet unproductive because they are too wet, shall be reclaimed, shall be efficiently drained, and thereby the wealth of North Carolina increase as a result of the activity of this Association.

TILE DRAINAGE PAYS

By H. M. LYNDE, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture

Mr. President and Gentlemen:—Tile Drainage Pays; perhaps a better title would be, "Tile Drainage, an Investment." One traveling over Eastern North Carolina is impressed with the large number of open ditches on nearly every farm, and wonders why drain tile has not been used more extensively. It has been estimated that from five to six million acres of land now in farms in the State are in need of better drainage. Probably not over 6,000 acres of this large area have been thoroughly drained.

The thorough drainage of our farms has too long been neglected. Everybody knows that a field where water stands during any part of the growing season needs drainage, but it is not so generally understood that the productive capacity of many other fields would be greatly increased by the establishment of better drainage conditions. It is essential for the healthy growth of practically all the cultivated crops that the soil occupied by the roots should contain air as well as water. It is therefore safe to say, in general, that any land where the ground water level stands within three feet of the surface for a considerable length of time after a period of heavy rain needs drainage just as much as land that is covered with water.

CAUSES FOR SO LITTLE TILE DRAINAGE

The extent to which tile drainage has been practiced in North Carolina is not such as to bring before its people the far-reaching importance of this form of improvement. Some tile has been laid in the draining of ponds, swales, and springs, and these are the places where tile drainage should begin, but not very many uniform systems have been constructed. In the Middle West, underdrainage is considered the most important requirement for successful agriculture. There is no reason why the installation of tile in the South should not pay returns just as large as in the Middle West where the soil is no better and the climate not as favorable.

Professor Day, of the Ontario Agricultural College, Canada, states, in a publication on drainage, that despite the success of tile drainage systems already constructed in that flat country the installation of tile has not been rapid. From observation and investigation he attributes this moderate growth to four causes, viz.:

1. The great benefits of underdrainage are not generally understood.
2. The lack of knowledge as to how to proceed to install a system.
3. A current impression that tile drainage is too costly.
4. The scarcity of farm labor, particularly of skilled labor.

Now these same reasons doubtless prevail in North Carolina as in Ontario. Perhaps also might be added the unwillingness to try new methods under changed conditions of labor and machinery. On the other hand, perhaps, the man who appreciates the value of tile drainage too often has not the ready capital with which to do the work.

We hope in this discussion today to impress upon you the great results of underdrainage as an investment, assuming that every one here appreciates the benefits to be derived from drainage in general. If you did not you would not be here. Tile drainage is the ideal form of farm drainage. A line of tile in the ground generally drains more thoroughly than an open ditch, especially in clay and loam soils.

SURFACE DITCHES DO POOR WORK

The common surface ditches from an agricultural standpoint are expensive and of low efficiency. They are often not deep enough, their grade is usually poor, and the water flows slowly. In clay and loam soils the percolation is very slow, caused by the sides of the ditch becoming more or less puddled and the soil spaces closed from the flushing of flood flows. The farm, too, is cut into irregular-shaped fields, which interferes with cultivation, and the ditches frequently occupy from 4 to 10 per cent of the planting area on many farms. Because they are in the way, they are often not spaced close enough together to give good results in draining; and furthermore, they have to be cleaned out from year to year. This adds to their expensiveness.

In tile-drained land the water is carried down through the soil and then off, instead of over the surface, thus replenishing the supply of soil moisture, and the physical condition of the soil above the water table is modified and improved. For this reason tile helps the crop to resist drought, making the soil drier in a wet season and wetter in a dry season, especially on clay lands.

ECONOMY OF TILE DRAINAGE

The statement that thorough drainage results in a deeper soil, with the consequent protection against drought, resulting in greater crop yields, has been presented again and again as an argument in favor of underdrainage, and yet seems to have had little influence in increasing the interest in this subject.

Perhaps the best way of showing that tile drainage pays is to consider it from the economic side, the dollars and cents side, by showing the advantage of tile over the open ditch, in the increase of the available planting area, the reduction of cost of farming operations, and the fact that tile requires very little attention, is permanent, and pays for itself in a very few years.

Probably no one who has ever given any thoughtful attention to the subject will question the fact that it pays to tile drain small areas where a single line of tile will do the work, but whether it pays to underdrain where all the land needs draining is a question about which there may be differences of opinion. The first cost of doing this work seems so large, and the lack of

ready capital often is an added discouragement. A responsible farmer can usually borrow money readily for the purposes of buying machinery, fertilizer, cattle, or other things to supply his more or less temporary needs. Why then should he not be able to borrow money for making a permanent improvement? On many farms there could be no better investment than a system of tile drainage properly installed. It is the belief of the writer that money thus used will prove not only one of the safest, but also one of the most profitable investments in many cases.

The open ditch has its place in all drainage work, but for farm drainage, its principal function should be as an outlet for tile drainage.

Every landowner should ask himself at least five questions concerning his drainage, namely:

1. What does it cost to dig a ditch?
2. What does it cost each year to maintain the ditches?
3. How much does tile cost?
4. How much planting area is lost to cultivation because of the ditches?
5. What would be the value of the crops that could be grown on this area?

The cost of construction of an open ditch is heavy. The amount of earth which must be removed is much greater than for underdrains of the same depth. A tile ditch, of course, must be graded carefully, but considering the smaller amount of material removed, the cost to dig a tile ditch ought not to differ materially from that to dig correctly a ditch that is to be kept open.

The cost of keeping an open ditch clear of weeds, silt and other obstructions will probably average in the neighborhood of one cent per linear yard annually, sometimes less and sometimes more. The cost of 4-inch tile at \$25 per thousand feet (this includes freight) is $7\frac{1}{2}$ cents per linear yard. Therefore, since the ditch had to be dug anyway, if tile had been put in, in the first place, it would have paid for itself in seven and one-half years in money saved in keeping the ditch cleaned out, for when put down correctly tile needs no attention except to see that the outlet is not obstructed. The interest on the money if it had not been invested for tile has not been considered in this comparison, but we will endeavor to show presently that the landowner will get a greater return on his investment than if he had put the money in the bank.

If the landowner were to take actual measurements of the width of planting space lost to cultivation by the open ditches on his farm, he would probably find that when the rows parallel the ditch the width would be in the neighborhood of ten or twelve feet, and that when the rows are at right angles to the ditch this width would be between twenty and twenty-five feet. These figures may seem rather large to most of you, but they are the results of actual measurements made on thirty-two ditches in Wayne County, and fairly typical, the speaker believes, of other sections of the State. The more improved the machinery, the wider the space lost to cultivation. Assuming sixteen feet as an average width and multiplying this by the total length of open ditches he would be amazed at the number of acres he does not cultivate.

The above point can probably be best illustrated by taking the case of an actual farm in Eastern Carolina, on which the actual length of open ditches has been obtained by a survey, and which is typical of many farms in that section. It is a productive farm, capable of producing a bale of cotton to the acre. The open ditches drain the land well, because the soil is of a more or

less sandy nature, drainage being necessary because of the flatness of the land with many depressions. The ditches, however, cut the tract up into many small fields. The total area under cultivation is 223 acres, and on this area are about five miles of interior open ditches. Assuming an average width of sixteen feet as lost to cultivation by these ditches, this means an area of over nine acres, or about 4 per cent of the total area of the tract. On this area nine bales of cotton could be grown, which at 10 cents per pound is worth \$450. The actual cost of cultivating this nine acres may be neglected, since it is less trouble to go straight across the land than to turn the team at the open ditch. Neglecting also the slight additional cost in picking the cotton, it may be said that the owner will receive an annual profit of \$450 by installing tile. By an expenditure of \$2,000, about \$9 per acre, which includes the cost of tile, digging a new ditch if necessary, laying and refilling, all the interior open ditches on this tract could be replaced by tile. The crops raised on this redeemed area thus represent an annual return of about 22 per cent on the investment. If the landowner borrowed the money at 6 per cent the loan could be paid back in less than five years, as a result of the increased yield of cotton alone, after which this increased yield is an annual profit for an indefinite time. Furthermore, we have not taken into consideration the cost of cleaning out the open ditches, which at 1 cent per linear yard would be \$88 annually, nor have we considered the decrease in cost of cultivation of the whole area by the use of improved machinery.

The farm just described is typical of many west of here, yet the speaker ventures to say that in this immediate vicinity are farms of a like area which have a greater mileage of open ditches than the one described. With ditches spaced 300 feet apart the actual planting area wasted is over 5 acres in every 100, assuming a width of 16 feet occupied by ditch and bank. If landowners could be induced to look upon tile drainage as a business proposition, and ascertain for themselves whether it will pay to invest money for tile, no doubt more work along this line of agricultural improvement would be done.

COST OF TILE DRAINAGE

What does it actually cost to install a system of tile drainage may well next be considered. There is an impression that tile costs more in North Carolina than in other states. When approached on the subject some landowners will reply, "Yes, I know it is a good thing, but tile costs too much. When it gets as low as in other states I will begin to use it." Except in some of the states of the Middle West the price of tile does not materially differ from that in this State. Furthermore, in the states of the Middle West there is a greater demand for tile, competition is strong, and many small factories have sprung up. Until there is more demand for this product in this State the price will not reduce materially; and as it is at present, it isn't much different from that of large factories making good tile in other states. Let's not wait for the price of tile to get lower, but go right ahead with this most important work, reaping the benefits now.

The actual cost of tile drainage will vary with the cost of the tile and labor, the nature of the soil, and the consequent depth and spacing of the drains. Tile of 4-inch inside diameter will cost \$16 to \$20 per thousand feet at the factory, and often \$25 per thousand delivered at the nearest railway

station. If 4-inch tile costs \$25 per thousand, 5-inch will cost about \$35, 6-inch about \$45, and 8-inch about \$80 per thousand feet, in carload lots. The cost of digging the ditch, laying the tile and refilling ought not to exceed 9 cents per linear yard for a ditch 3 feet deep.

With the above prices and assuming an acre of land to be drained with 4-inch tile, the cost will range from \$16 for tile spaced 150 feet apart to \$40 for tile spaced 60 feet apart. To this cost must be added the cost of larger mains, hauling of tile from depot to farm, and cost of accessories like silt-wells and head-walls. Also add to this the cost of engineering. On lands not requiring a uniform spacing, the cost may be as low as \$8 per acre. In North Carolina, a spacing closer than 60 feet on land used for general field crops makes drainage so costly that it is not recommended except on valuable land. A spacing of 100 feet is giving good results on the Portsmouth soils of the Coastal Plain region, and 150 feet in some sections. For trucking crops a closer spacing is necessary than for general field crops.

COST OF CEMENT TILE

A word about the cost of cement tile. Cement tile, if properly made at a factory, costs about the same as clay tile in this State. One of the arguments made in favor of cement tile is that they can be made right on the farm where they are to be used, and that they can be made cheaper than the cost of clay tile. For this reason men are interested in the subject. However, they should be made well or not at all, using a good, clean, sharp sand, varying in size of particles from fine to coarse, and the mixture should not be leaner than one part of cement to three parts of sand, and they should be thoroughly cured. If made properly, persons who have given the subject attention state that there is probably no profit in selling them at prices lower than the current prices of clay tile. If a man can make them in his spare time on the farm, it will probably be cheaper than buying clay tile.

It is evident, then, that the tile drainage of farm lands is not an inexpensive operation, if one considers only the first cost. The exact knowledge of this cost, however, has little significance unless at the same time a fair idea of the profit to be expected can be had. This we have endeavored to point out. Tile drains, properly installed, are a permanent investment, and almost no maintenance is required. The increase in crops in from six to ten years will usually pay for the cost of drainage, after which this increase is an annual profit for an indefinite time.

There is an impression that our Southern lands are too low in value to justify this seemingly expensive work of tile drainage. It is probably true that at least two-thirds of the area of the State may be termed "waste land." What does this mean in our eastern section? It means that much of the "waste land" is *wet* land. Most of the high places have been settled and cleared, but our richest soils are not yet yielding their full value. The soils which are in need of drainage are in general of much greater fertility than the average soils of the State. With an increase in population there will be an increased demand for land, and as the price increases it will become more and more profitable to underdrain our wet farms. With the high prices that all farm products command today, and the numerous markets available, it seems that it would pay to underdrain all land where there is the slightest chance for failure or partial failure. By underdrainage our so-called "cheap lands" would become the most valuable agricultural lands in North Carolina.

SOME ACTUAL RESULTS OF TILE DRAINAGE

The usefulness and helpfulness of underdrainage is not to be measured by what we *promise* but by what it *performs*. No one is so well qualified to speak of the value of tile drainage as those who have tried it. For the purpose of obtaining data as to the results of tile drainage as farmers have experienced it, we sent out a list of questions to those in the State who have used tile. Perhaps the most effective way of presenting their answers is to quote directly from several of them. Time will not permit us to give very many of the replies. Starting in the western part of the State and coming east we have:

1. From McDowell County:

"Land that used to grow bullrushes and saw-grass now is the best land I have, and I would not take \$150 per acre. The land I have drained has more than trebled its yield and almost doubled the value of my farm. My land originally had a great many open ditches that did not properly drain the land, and were in the way of cultivation. Since I put in tile my tenant can easily cultivate one-half more land, and doubles his yield per acre with same cost to cultivate."

Comment: This man began using tile in 1880. He commenced by draining land that was no good as it was, but is now draining land that looked dry enough when the other was wet. He has used four carloads of 3, 4, and 6-inch tile on 22 acres, putting tile where it would do the most good. The 3-inch tile cost him 1½ cents per foot, 4-inch tile 2 cents per foot. The labor for installing the tile he estimates at about the same cost as the tile itself. The total cost was probably \$35 to \$40 per acre.

2. From Guilford County:

"My farm is fine sand formation, very level for this section of country, and is known as what is termed wet land, viz., there are quite a lot of spouty places, and it takes a long time to dry out so we can cultivate after rains. I bought this place six years ago for \$1,900. Cut some open ditches first year; second year cut quite a lot of lateral ditches and put in poles and slabs. This did well for the crops, but is bad to get clogged up. Then I and two neighbors formed a copartnership and bought a machine to make cement tile, and we have been making tile, ditching, etc., every spare time since, and shall continue until the job is complete. In 1913 our crop was worth more than we paid for the farm, and some eight weeks ago we refused \$5,000 for it. So you see I am an underdrainage enthusiast. Our last two crops averaged about 50 bushels in 1913 and 35 in 1914."

Comment: Increase in crop values average about 300 per cent; increase in assessed value of land, about 40 per cent; selling price of land increased 300 per cent.

3. From New Hanover County:

"I began using tile drainage 20 years ago, putting it in the wettest places first and extending the system as I could. Now have my whole farm of 40 acres tiled. The cost of tile per acre has varied from \$18 to \$25, owing to the cost of labor, etc. With truck crops, it has fully paid for itself in one year. I am sure that my success has been due to tile drainage. It is the extreme wet or dry years that prices are best. A good crop where others fail means good money for that crop. Tile helps in a dry season. While we have had

the driest summer (twelve weeks without rainfall enough to wet the ground an inch) in the history of the country, I have tilled land that will harvest 50 bushels of corn to the acre."

4. *From Beaufort County:*

"Crop values have increased one-fourth because of tiling. Land of same character with open ditches worth about \$75 per acre. My tilled land would go readily for \$150 per acre."

Comment: This man began installing tile in 1895, and now has his whole farm of 120 acres underdrained with 35,000 feet of tile. All the old open ditches have been replaced by tile. From data obtained the average cost was about \$10 per acre. As a result of installing tile and doing away with open ditches, he states with regard to the cost of farming operations, "With one-half the men as before and same teams can cultivate oftener, as we use improved machinery."

So we might continue. The above experiences as well as others received are interesting and convincing, and it is hoped that they will convince others that "Tile Drainage Pays."

A TILE DRAINAGE ACT

How can more interest be stimulated in underdrainage? It has been intimated that possibly the large first cost of the work and the lack of ready capital at the disposal of the farmers has had something to do with the slow progress in this field. If it were easy to obtain money for this character of work it is believed more along this line could be done. Unquestionably tile drainage improves the producing power of farm land. Increased producing power means increased farm land values, and increased farm land values always result in an increase of land values generally, in the immediate community. To the municipality or political subdivision in which such lands may be situated in the end come increased taxes. It seems, therefore, that the political subdivision should offer its assistance to bring about this increase in revenue. From experiences of municipalities which have recognized the desirability of promoting the drainage of their agricultural lands, valuable suggestions can be gained.

In the province of Ontario, Canada, there has been in force since 1897 a Tile Drainage Act which enables the council of a town, village, or township to pass by-laws whereby it can borrow money for tile drainage purposes in sums not less than \$2,000 and not exceeding \$10,000, and issue therefor debentures to the municipality in sums of \$100, payable within twenty years and bearing interest at the rate of 4 per cent per annum. To meet the increased demands on the townships for loans, in 1914 the limit of their borrowing capacity was raised by legislative enactment to \$40,000. A person desiring to borrow money for tile drainage may, under this act, do so by making application to the council for a sum not exceeding \$1,000 and not in excess of 75 per cent of the cost of the drains to be installed. The council collects for a term of twenty years from the landowner who borrowed the money a special annual rate of \$7.36 for each \$100 loaned. The drainage work must be approved by an inspector employed by the council before the money is loaned. In 1909 the State of Vermont enacted a law similar to the Ontario Tile Drainage Act whereby the landowner is able to borrow money for tile drainage and repay it to the municipality in twenty equal annual payments. From reports received by the United States Department of Agriculture it

appears that the farmers of Ontario are freely availing themselves of the loan privileges provided by the law of that province, and no failures to promptly make annual payments have been reported. The experience of Vermont with her Tile Drainage Act has not been so successful. In fact no obligations have been incurred under the act. Shortly after the passage of the law the Commissioner of Agriculture communicated with a number of bond houses to ascertain whether they would purchase debentures issued by the municipalities in accordance with the act, but as the law does not make the debentures an obligation against the entire municipality, none of the houses were willing to buy the bonds on a 4 per cent basis.

The thought has occurred to the speaker that if a law similar to the ones described could be enacted in North Carolina impetus and encouragement would be given to the important work of tile drainage on farm lands, and the expert supervision which the law would provide for should insure the quality of the work. Until the passage of the State Drainage Law for the drainage of our swamp and overflowed lands, no great advance was made in the drainage of these large areas. Since its passage we all know what has been accomplished. If such a law has worked such a transformation in our large swamp areas, why should not a tile drainage act help to do the same thing for our wet farms?

The experience of Vermont, however, suggests the necessity for caution if any attempt is made to secure legislation with a view to extending financial aid to farmers wishing to undertake tile drainage. Those who attempt to draft such a law should remember that what may be constitutional in Canada might not be constitutional in North Carolina, and that the financial standing of Canadian municipalities has been regarded rather highly for some time.

SUMMARY

The speaker has endeavored to show how little tile drainage work has been done in North Carolina, and some probable causes for this slow progress. The economy of tile drainage and its superiority over open ditch drainage on our farms has been described, followed by a discussion of the actual cost of tile drainage. Some actual results of tile drainage as farmers have experienced it have been given, and their statements ought to speak louder than any theoretical discussion of the subject. Lastly, there has been included a suggestion indicating the desirability of having a law enacted which will make it possible to finance tile drainage on a larger scale.

Our Southern lands are not too low in value for tile drainage. The use of modern machinery demands it. As the *Progressive Farmer* stated several years ago, "*Let us have better land and bigger fields next year.*"

TILE DRAINAGE AND TILE DRAINAGE FAILURES

By F. R. BAKER, of the North Carolina Department of Agriculture

In studying the different subdivisions of drainage, I sometimes ask the question, which is the most important—whether drainage of wet lands by means of open ditches and underground systems, or whether drainage of hillsides by means of terraces, commands first place. If our Convention were composed of nothing but Piedmont farmers, I would not hesitate in laying stress on drainage by terracing; but yet if I were speaking to an audience

in the eastern section, I would most likely select the subject of drainage by means of canals or by underground methods. But today, being at a Convention whose membership covers the entire State, the question of the most important subject is a debatable one.

It is the prevalent opinion that drainage of the swamp lands in the State is relatively of much less importance to our agricultural interest than is the proper drainage of the millions of acres already under cultivation.

It should be understood that the situation of the upland is more critical than that of the swamp land. The latter is wet throughout the entire year, and it can be dealt with with no uncertainty. On the other hand, the upland is intermittently wet or dry at one time or another, introducing a state of uncertainty which makes the problem of proper handling and cropping a serious matter. The upland suffers from the extremes of moisture conditions, and extremes are always more serious than constant dampness or constant dryness.

Poorly drained farm land, as exists generally throughout eastern and central North Carolina, is usually too wet in the spring and too dry in the summer; consequently there is a resulting poor crop. The roots of crops planted on such land develop very slowly and cannot penetrate deeply into the soil, due to the high water level in the spring; and later on in the season, during drought periods, the water level drops quickly, leaving the roots high and dry to suffer accordingly. If we concede, then, that underdrainage is more important and reaches the needs of more individuals, it should be decided which form of underdrainage meets best the increasing needs of modern conditions.

Underdrainage in North Carolina dates back many years. Poles, boxes, and stones were first used, but as they would easily rot or become filled with sediment, something better and more permanent was sought. Clay tile of different shapes and sizes was then introduced on several farms. This was about fifty years ago. This tile gave gratifying results, as is evidenced by the fact that the early users are the most enthusiastic supporters of tile drainage today. Therefore, after this long experience and further study, it is now generally conceded that the round tile is best adapted for farming purposes, and good practice has abandoned the use of tile less than four inches in diameter.

Yet, despite the successes, tile drainage has spread slowly. Even if we were to overlook the many beneficial results obtained from using it, and if there is no difference in the actual plant growth on undrained areas, there is still a large element of loss in the farming operations, due to the fact that crops cannot be seeded at the same time. They do not mature at the same time, and consequently all operations are upset, which means loss of labor, greater expense, and much inconvenience.

Probably the greatest argument in favor of underdrainage is the elimination of the open ditch on planted areas, and on the other hand the greatest argument against underdrainage is that the increased crop yields make an increase in the expense of gathering or harvesting.

I will not go further into the benefits of tile drainage, as Mr. Lynde has taken up this phase of the subject in detail; but having the bright side presented, I feel that the discussion will be incomplete without pointing out the dangers to which the users of tile are liable if careless systems are in-

stalled. I refer to the subject of tile drainage failures. Why do they fail? and what is the extent of its influence on the future use of tile drainage operations? This is a subject that requires much study and investigation before all of the causes of failure can be determined.

Many thousands of dollars have been wasted in underdrainage because it was undertaken without an adequate understanding of the subject and without a knowledge of the imperative demand for utmost care in every detail. The purchase of so many tile, the digging of a ditch, and the laying and filling of these tile are far from having an effective tile drainage system.

On the other hand, one must be able to select the right kind of tile; know how to dig a ditch to proper grade; understand how to lay these tile; and last, but not least, how to back-fill the ditch. Some knowledge of each factor is necessary if a permanent investment is sought.

It is true that many shiftless and careless systems have been installed and are continuing to work, which to me seems strange, but it is safe to say that the majority of such cases end in failure. Not many days ago a first-class farmer had to take up over 2,500 feet of tile. The result has been a big loss of time, tile, and money, and the necessity of doing the work all over again. The greatest lesson that this man learned was what he should have known before attempting to lay the first joint.

Now the serious question is, what influence will these failures have on neighbors who are contemplating similar drainage?

How many appreciate the relative value of an efficient outlet for a tile drainage system? A good outlet is necessary, one that will take away the water freely after it leaves the tile. If it is allowed to become filled with weeds and sand, thus interfering with the free movement of the water, the results will probably end in failure.

How many appreciate the necessity of protecting the mouth of the tile? Destroy it, and the entire system is in danger. This last joint is the most important one in the entire system. Consider for a moment the dangers to which it is exposed. Weeds and other rank growths are allowed to choke it. Stock often trample on it and break it off. Sometimes it is undermined by water and disjointed. Small animals and insects will enter the mouth of the tile and stop up the drain. A certain gentleman went down to his tile outlet to see how it was working after a hard rain. He was just in time to see a muskrat nest float out, and was indeed fortunate in having it come out at all.

The best way of overcoming these troubles is to support the ends of the tile by a simple head-wall and place a wire screen over the mouth. The head-wall can be built out of large stones, concrete, or brick. Since corrugated culverts have come into use, it would seem that a long joint of this would serve well as an outlet.

Other important factors lending their influence to cause tile drainage failures are improper grades, poor laying of tile, broken joints in the system, and improper material to cover the tile. Yet such avoidable failures as these have caused many to turn against the use of tile on the farm.

The problem then, as I see it, is an educational one: to teach the proper methods of installing systems so that the initial cost will be the whole charge for a permanent investment.

DISCUSSION OF THE GENERAL SUBJECT OF TILE DRAINAGE

MR. PRATT: Last year when we were at Wilson we were very fortunate in having the opportunity of being taken out where we had a practical demonstration in connection with the laying of tile on one of the farms in that section. This was laid by one of the best experts we have in this section of the country.

A DELEGATE: How would it do to appoint a committee to take up a tile drainage law? I make a motion that it be referred to the Legislative Committee, and that the subject of tile drainage be referred to this committee.

MR. PRATT: A motion has been made and seconded that the Legislative Committee take up also during the coming year the question of a tile drainage law and to report to the Convention when it meets in 1916.

Motion passed.

THE WORK OF THE DRAINAGE DIVISION OF THE NORTH CAROLINA
DEPARTMENT OF AGRICULTURE

By F. R. BAKER, Drainage Engineer, North Carolina Department of Agriculture

The North Carolina Drainage Association is now passing through its eighth year. It has accomplished many things. The valuable law by which drainage problems can be solved is probably its most important work. Through this law, many drainage districts have been organized and thousands of acres of land have been reclaimed. In fact there can be seen a marked increase in the interest in drainage from year to year, and I will endeavor to tell briefly what part the Drainage Division has played in attempting to help spread this interest.

Realizing the importance of drainage in agricultural work, there was formed a cooperative agreement between the North Carolina Department of Agriculture and the United States Department of Agriculture for the promotion of agricultural development along drainage lines, with particular attention to farm drainage. It represents the recognition of a widespread need for improvement in our agricultural production, and we believe that the North Carolina Drainage Association was a leading factor in its establishment. It is therefore a coordinating force with this Association, and we believe that it is well for all forces with common cause to work together.

The purpose of the drainage office is to assist farmers in the draining of their lands, by advice and by investigations of the principles involved. We are prepared to examine their lands, develop a plan of drainage, and give an estimate of cost. We are trying to conduct the work along educational lines, introducing correct principles and methods in different sections of the State, so that enthusiasm for drainage will grow.

Our work may be classified under the following heads:

1. Improvement of Farm Lands now Under Cultivation.
2. Investigations of the Drainage of Swamp Lands.
3. Collection of General and Technical Data on Drainage.
4. Preliminary and Reconnaissance Work.

Considerable interest is being shown in tile drainage and terracing throughout the State. Thirty-nine examinations have been made for tile drainage systems scattered over twelve or more counties and comprising an area of over 2,000 acres. On this area over 65,000 feet of tile ditches were staked off. Fourteen examinations were also made for terrace systems covering an area of about 900 acres, resulting in about 96,000 feet of terraces being staked off. Much interest is also being shown in the drainage of swamp and overflowed lands. Fourteen examinations have been made for swamp lands, comprising an area of over 400,000 acres; and seventeen examinations have been made for overflowed areas embracing over 37,000 acres.

We have also established two experimental plats for the purpose of making a study on the spacing and depth of tile lines. In connection with the experimental data, we have established two gaging stations on Piedmont streams for overflowed areas embracing over 37,000 acres.

Furthermore, we have conducted a number of tile drainage demonstrations and drainage exhibits, which seems to be a good method for reaching the individuals.

This work in the State is a large one, and we feel that any force with an aim for drainage accomplishments will do good. We therefore sincerely hope that the Drainage Division and the North Carolina Drainage Association can work together for a common cause.

Mr. N. L. Cranford of Winston-Salem, during 1915 printed in a pamphlet entitled "Drainage Pays" a series of letters from progressive farmers of Piedmont North Carolina, telling of the splendid results obtained from draining bottom lands. It is believed that these will be of value to those who are interested in the reclamation of the overflowed lands, and they are incorporated in this report as

RESULTS OF DRAINAGE IN PIEDMONT NORTH CAROLINA

From Cabarrus County:

CONCORD, N. C., R. F. D. No. 2, October 14, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Will answer your letter with pleasure. We had our swamp lands drained last December, and the bad weather last winter prevented a great deal of land from being plowed, but we have some as fine corn as you have ever seen grow, and we have a fine crop of clean hay. We are gathering corn and hay this year where last year we raised frogs and mosquitoes. The people are highly pleased. It cost about \$20 per acre to drain our lands. If you will come down, would be glad to take you over our ditch.

We made some mistake in shaping our ditch. It was cut 24 feet at the top, 14 feet at the bottom, 10 feet deep. That gives you too straight a bank. If we had only cut bottom of ditch 10 feet our banks would have stood up better. If there is any information that I can give you, I would be glad to do so.

O. O. OVERCASH.

CONCORD, N. C., R. F. D. No. 1, October 11, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Yours to hand and contents noted. Would say in reply that it cost \$18 per acre, and that it will pay you to dredge it if the stream is not too large. But to tell you anything about yours I would have to see the stream myself. It will pay you to have some one to look over your district that has had some experience in the business. I went to see several creeks that had been dredged before I would dredge. There are a good many things to take into consideration. The most important thing is the Board of Viewers. They should be men that know what they are doing, men that have had some experience in the matter, to give justice to all concerned.

I have some very fine corn, but one big overflow did some damage.

You will always find some kickers, no matter what you do.

If there is anything that I can do for you let me know, and if it is possible I will do it.

Yours as ever,

CHAS. A. FISHER.

CONCORD, N. C., R. F. D. 2, September 23, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—In reply to yours of 17th inst., will say my bottom land on Coddle Creek was dredged last winter, the work was finished March 12th. I was taxed on 65 acres of class A and 32 acres class B. There is just about 300 rods through my land and my dredge bill was \$1,923. I afterwards spent \$125 in three-foot ditches. This land for the last thirty years has been almost worthless, used for pasture and swamp hay. I succeeded in getting 30 acres planted in corn, which was no easy job, and through the month of July people came from a distance to see the corn. It was a pretty picture and was generally estimated at from 60 to 100 bushels per acre. About the 10th of August we had a freshet that put the water three feet deep all over the land, and then four weeks of wet weather which damaged the corn at least one-third. Now a lot of this corn was not planted until June 15, and I think I can safely expect 1,200 bushels of corn. I have also made 105 loads of hay on what I did not work. This hay would have been worthless without the ditch. Our ditch, which is 14 feet at bottom, 24 feet at top, and 10 feet deep, has taken care of all rains nicely, until the freshet of August 10th. I will also tell you I was at the start not in favor of dredging, but to please the majority of landowners I agreed to go into it, and now my opinion is that if the ditch lasts ten years dredging is cheap at any cost. I will also tell you that within the last sixteen years I have seen the water, four times, five feet deep and 1,000 feet wide over this land. Had I the work to do over I would prefer a ditch 10 feet at bottom, 30 feet at top, and 10 feet deep. Forty and fifty years ago I made fine corn on this same land, but for thirty years I have not had a plow in it.

Wishing you success if you dredge.

Yours respectfully,

J. A. RANKIN.

CONCORD, N. C., October 11, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Replying to your favor of the 7th inst., will say I am in one drainage district and think I will be very much benefited. This is my first

year and it has been a severe test, as our stream has had more water to contend with than for a number of years, and yet I have some fine corn on land that is often too wet to mow. It made fine grass, but it was so low and wet that I got very little good hay. Then our ditch was cut too late to get our lands in condition in time for a good crop, and some of it was poorly prepared; but most every one is well pleased, and it has opened up a fine body of corn land, and I believe our district will raise 10,000 bushels more corn than the same land would have raised without the drainage. There are 1,300 acres in this district, but some of it is uncleared and a good deal was not planted this year on account of the work being completed too late to plant. We expect much better results another year.

Wishing you success in your enterprise, I am,

Yours truly,

JOHN P. ALLISON.

CONCORD, N. C., Route 2, October 11, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—I will this evening write you in answer to yours of the 7th inst. I like the drainage work fine. If our land had not been drained we would not have gotten anything off the bottom this year. We have fine corn and hay.

About the cost—that will depend on how wide your bottoms are and how long your ditch will be. Our ditch is five miles long, and our A grade was \$23. I think draining is the only way to work the bottoms. We are all pleased with our drainage. It has been drained ten months.

Yours very respectfully,

G. M. TAGGART.

From Mecklenburg County:

CHARLOTTE, N. C., October 15, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—As requested as to what I thought of drainage work, beg to say that in the past four years I have spent about \$5,000 for drainage and I consider the money well spent, and if I had the work to do over again I would do the same as I did.

The creeks I had dredged were made about 22 feet wide and about 10 feet deep, and I wouldn't recommend any smaller size.

If there is any other information you would like to have and if I can give the information, I will gladly do so.

Yours very truly,

GEO. P. WADSWORTH.

CHARLOTTE, N. C., October 12, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—In reply to your request relative to our experience with drainage work, we will say that the writer has had a great deal of experience and is really in a position to testify accurately.

I represent a plantation that was recently drained in which there was approximately one hundred acres of bottom land. This land prior to the dredging was not worth \$1 per acre; but since it was dredged, the land today could not be bought for \$200 per acre. This is a plain fact, with no exaggeration whatever. The entire draining cost us approximately \$1,300, and we

are sure that we have a benefit of not less than \$15,000. I could state this for several others, but being personally interested in this particular place, I do not hesitate to give this as my experience.

If you are contemplating any drainage work, I can say that if your experience is as satisfactory as mine has been, you will never regret having the work done.

Trusting that this information will be of some service and with kindest regards, I am,
Yours truly,
E. R. SMITH.

CHARLOTTE, N. C., October 12, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—In response to your inquiry as to my opinion of drainage and my opportunity for forming my opinion, will say that my first impression before I knew the benefits was adverse, because I felt that it was an extra and unnecessary tax levied upon those living along the area. At the time I was living within a few hundred yards of the creek proposed to be drained. The mosquito was a regular unwelcomed guest at my home. The promoters of this drainage area assured me that if the creek was dredged properly I would not be subjected to near so much torture, and consequently would not so likely have malaria in my home. I was in the minority, so the ditch was dug. I am glad to testify that there is not nearly so much malaria in our community as was found prior to the dredging of our creek.

Since that time, in order to protect my financial interests in a transaction, it became necessary for me to become one of the owners of a 400-acre farm which is situated on McDowell Creek in the northern section of our county. There is in first and second bottoms on this creek approximately 75 acres, which at the time of our purchase was densely covered with briars and willows. After considering how to make use of the bottom until the land-owners along the creek would consider dredging the creek, we decided to clear away all the growth for the purpose of making pasture. In the dry season of August I put the laborers to work, and in many places they found the ground so wet and miry that it was impossible to work.

The quality of this soil was such that it set us to work to get the creek laid out as a drainage area. After this was accomplished and necessary financial arrangements were made the ditch was dug. The boat had made sufficient progress by May, 1914, to justify us in planting what we had cleared. Then in August, 1914, I had the remainder cleared, and this year we have the whole area in corn. Many farmers have visited our corn fields this year, and 4,000 bushels is the lowest estimate placed by any of them on the 75 acres for this year.

From the standpoint of health, drainage has proved to me that it is a success, but even more so as an investment.

Yours very truly,

S. W. DANDRIDGE.

CHARLOTTE, N. C., October 12, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—At your request I am pleased to express to you my views and opinion as to the drainage of our farm lands in this county and Rowan (where it has been done). I was one of a jury of three to go over the entire

system of work done here in order to classify same, and think I know whereof I speak. Had I any land in Mecklenburg and could get it, I most assuredly would not do without it, for I have seen the "desert blossom like a rose."

My farm in southwest Rowan contains something over 400 acres, with Sill's Creek (before full of sand) running through at least 65 acres. I was enabled to mow about one-half of it; the balance was to pasture, and wet at that. Our people put their heads together last winter, and this spring the big ditch was completed. My man began to plow during the winter for corn, and was enabled to get in about one-half of the land. I wish you, or any farmer, could see my crop of corn, having had only two workings. My man estimates it at from 800 to 1,000 bushels. When I get the balance I intend for corn, I feel pretty well assured I can begin to pay for my drainage work with what I do not consume on the place. This land only gave me hay before this ditch was dug. I think I am safe in saying it has added at least 50 per cent to my farm, and I am sure the 65 acres would bring \$100 per acre. Now I failed to mention this fact in connection—"Health" (worth them all). My man said to me before I bought the place that it was "chilly," and so it was, but I am happy to state I feel they are things of the past. Your people will never regret it if they ever have it done.

Wishing you success, I am,

Very respectfully,

GEO. M. PHIFER.

From Iredell County:

STATESVILLE, N. C., October 9, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR MR. CRANFORD:—I have your letter about the drainage work here. I have had no work done myself, but I am quite familiar with the work that has been done, and it was done, some of it, at my instance. The first work done in this section was Clark's Creek in Catawba County. Then Third and Fourth creeks in Iredell county were dredged. Later a creek in Caldwell was dredged. Since that time one or two streams in Rowan and two or more in Cabarrus also have been drained. Very fine corn is now growing on the bottom lands of all these streams.

Of course these bottoms overflow sometimes, but that is the case on all streams. It was not the intention of the farmers here, and the engineers did not promise a canal that would carry the water at all times. The fact that farmers have been able to grow large crops of corn and grass on these bottoms is convincing evidence of the value of the work.

One farmer on Third Creek, two years ago, made about 4,500 bushels of corn where he had been making none, or next to none. Another made 1,700 bushels.

I think it pays well to dredge these streams and reclaim the low land. It is expensive to try to grow corn on upland all the time. The draft on the land is too great. It is almost impossible to keep up the fertility of the land. When corn can be grown on bottom land, and the upland used for grain and clovers, it is not a hard proposition to keep up the land.

I hope you can get the creek dredged. I take it you mean Muddy Creek. It needs it very much. I hope this information will be satisfactory.

Yours truly,

E. S. MILLSAPS,

District Agent.

From Gaston County:

GASTONIA, N. C., October 13, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Yours to hand a few days ago, and noted. There have been two creeks, Long Creek and Crowder's Creek, in Gaston County, dredged in the last few years. I am very familiar with the lands on both these streams and am secretary and treasurer of the commission which dredged Long Creek. These lands were almost worthless before they were drained; now they are in cultivation and some of the farmers claim to be making from 50 to 100 bushels of corn per acre. On each of these streams we made an assessment of \$15 per acre, to be paid in installments of \$5 per acre for three years. This was for the lowest, wet lands, and the assessments were less where the land was not so low and swampy. The health of the community has also been greatly improved by getting clear of the chills and fever. We still have our dredging machinery, and the same is for sale cheap. If you get your district organized we would like to take this matter up with you. Please let me hear from you later.

Yours truly,

E. L. WILSON,
Secretary-Treasurer.

Gaston County D. Com., No. 1.

STANLEY, N. C., October 13, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—Your letter of the 9th received and note that you contemplate dredging. In regard to our ditch, will say that we would not be without it for twice what it cost us. Our land was not worth over \$10 per acre before it was ditched, and now what has been sold since has brought \$100 per acre, and very little has been sold at that price. I have 75 acres on the creek that was not bringing me anything, and now I am getting about 50 bushels of corn per acre on all I have cleaned up. There will be enough corn raised on our creek this year to pay for the entire dredging bill. Our creek has not been out of the banks but three times since it was ditched. By the time we get ours paid for it will have cost us about \$20 per acre, and I believe it is worth \$50 per acre to us.

If you can get some of the interested parties together and will pay my expenses I will be glad to come over and tell them just what our ditch has done for us.

If there is any further information I can give you I will be glad to answer all questions.

Yours very truly,

W. R. RUTLEDGE.

MOUNT HOLLY, N. C., October 15, 1915.

MR. N. L. CRANFORD, Winston-Salem, N. C.

DEAR SIR:—I have your letter of the 7th inst. I should have written you sooner but have been away from home practically all the time. We finished our creek nearly one year ago. We began eighteen months before we finished. The landowners on the upper end of the creek made more than enough corn over and above their expenses to pay their entire dredging bill, where they had been making two or three hundred bushels, and that only occasionally, and a lot of muddy hay. They gathered 1,000 bushels each last year, and I understand it is better this year. My land is on the lower end and I did not get to put it in last year. I expect to gather something like 1,200 bushels

this year, and I didn't get one-half of mine in, but I pastured 40 head of cattle on that not tended. I will say, with the season we had this year and the creek not dredged I would not have made 100 bushels of corn, and I could not have pastured my land half of the time. And where our land was practically worthless before we ditched, you can't buy an acre for less than \$100 now. We are so well pleased that we are contemplating in a few years to run over it again, throw out the stumps, canes, etc. Our dredging cost us approximately \$17 per acre, but we still have the boat. Should we be able to sell it for something like 50 per cent of what it is worth it would reduce our cost to about \$15. We did not contract, and would not if we had it to do over. It is my opinion that if you have something like 100 acres to the mile it is the best investment any community can make. Any further information that I can give you will be glad to do so; and would like for you to come down and look over our creek, for we have one of the most treacherous creeks in the country and one of the longest. We would sell you our outfit cheap also.

Yours very truly,

T. L. WARE.

RESULTS OF FARM DRAINED SWAMP LAND IN EASTERN CAROLINA

The following paper was read by Mr. B. E. Rice, Industrial Agent of the Norfolk Southern Railway at the semiannual convention of the National Association of Railroad Industrial Agents at St. Paul, Minn., in May, 1915. Mr. Rice was a most active supporter of the North Carolina Drainage Association, and intensely interested in not only the reclamation of these swamp lands but their utilization, and it is believed that this paper will be of great interest to the readers of this report.

INTENSIVE FARMING IN THE DRAINAGE BELT OF NORTH CAROLINA

By B. E. RICE

The Coastal Plain regions of Eastern North Carolina represent conditions unknown elsewhere in America. The geological formation of the territory proves that it was formerly a part of the ocean bed, and that earth upheaval and changing conditions placed the area a little above sea level.

By the laws of gravitation the movement of rainfall water from mountain top and the elevated regions is toward the seashore, and thus, during centuries of time, the residual soils and silt from the higher lands to the west have slowly moved eastward and become a deposit over the lower areas along the ocean shore. The results is that the entire Coastal Plain section of Eastern North Carolina represents a surface deposit of soil fertility contributed by thousands of square miles of territory to the westward, the mother soil base extending even to the mountain tops, dividing the Atlantic slope from the Mississippi basin.

LEVEL SOIL

From the Carolina coast line the soil area for an average of fifty miles inland represents an almost absolutely level surface, as indicated by the

location of the sounds and broad rivers which intersect this entire east coast territory at intervals so frequent that they give to the country the appearance of a gigantic spider web.

Prominent among these waterways we mention the Albemarle Sound, the Pamlico Sound, the Neuse River, and the Pamlico River. These represent natural basins or waterways, and lying midway between them may be found a low ridge or watershed which directs the drainage flow toward these outlet basins. To any one familiar only with mountains or upland territory, it would be difficult to appreciate what a fall of only one foot per mile means in the way of drainage possibility to a level country. In Eastern North Carolina the word "uphill" may mean an elevation not exceeding one foot per mile, and yet this slight surface variation creates a drainage possibility that unlocks the great agricultural wealth of over 3,000,000 acres in North Carolina alone.

In this coastal region there exists a queer condition, in the fact that the dividing or watershed areas, the lands with the greatest elevation, represent the richest type of soils and are locally known as "swamp lands." Of a truth it may be said that the swamps of Eastern North Carolina are the hilltops, as such is the veritable fact. The lands lying near to the streams or waterways, and which are of a lower level, are almost invariably the light gray soils and of a sandy-clay type. These do not contain more than the ordinary amount of humus usually found in soils of that type, but as the surface level gradually increases, back from the water line, there is a change in the soil condition from gray to black, and the surface humus and black soil depth increases in proportion to the elevation increase, until at the dividing watershed this black soil accumulation will be found to measure from six to ten feet in depth. This accumulation represents centuries of decaying vegetation, grown on the original silt and deposit soil brought down from higher lands to the west. The humus in this black soil will vary from 40 to 90 per cent, the greater portion of the areas representing from 50 to 75 per cent of vegetable matter in various stages of decay.

SWAMP LANDS

With reference to the statement that the so-called swamp lands of Eastern North Carolina are the hilltops, and in refutation of the local use of the word "swamp," I would say that the dictionary definition of the word "swamp" is "a low spongy land," and the Bible teaches that the Creator made all things for the best, inference being that man could not improve on Nature.

Conditions in Eastern North Carolina disprove both the dictionary and the Bible in theory. Not but what both are right in the true facts, but man is wrong in the theory of application. On the watershed areas of Eastern North Carolina today man is actually improving on Nature by the installation of additional drainage, converting the "unfit-for-tillage" lands into a rich farming district. These lands are of a swampy condition, but do not represent the actual swamp of dictionary distinction.

Only within recent years has the State of North Carolina had practical or effective drainage laws, hence the rich soil areas of the Coastal Plain section have long remained undiscovered and unappreciated. The law of supply and demand, the rush of farm land settlement in the United States, now brings this area into prominence. This is due to the great possibilities for

ready drainage and easy development. The quickness with which these newly drained lands come into production and the low cost of development and operating, averaged against the valuable crop yield, show ready cause for these lands coming into good demand.

As a rule the greater portion of the level or drainage areas are covered with thick timber. Frequently large areas have been burned over by destructive forest fires, the greater portion of the timber growth being eliminated and easy development conditions presented. With the installation of main canal drainage in these open land areas, development becomes only a question of clearing the land of reeds and brush and the removal of burned logs and stumps sufficient for rough plowing. This clearing usually requires a per acre cost ranging from \$4 to \$10, after which the land can be rough broken with a grubbing plow at a cost of from \$2 to \$4 per acre. The land becomes immediately available for planting, corn usually being the best and most successful first crop.

DEVELOPMENT WONDER

The development wonder of the new lands, however, is the subjugation of the more thickly timbered portions of the black soil areas. In the hardwood districts of the Northern and Western States the converting of timber lands into cultivated fields requires several years, between the axe and the plow, time sufficient for the stumps and logs to rot away. In contrast we find that the black soil timber lands of the Carolina drainage districts are covered almost wholly with gum and other softwood varieties, quick to decay, and nearly all of surface root formation.

After the timber of milling grade has been removed, contractors, at an average cost of 88 cents per acre, will cut down all the remaining trees of every size and kind. Frequently as much as a thousand acres are cut down for a single development operation. About the first of May the entire area is set on fire and thoroughly burned over, the thicker and more dense the standing timber supply, the greater the amount of fuel, and consequently the hotter and more intense the fire. This fire also creates a rich ash deposit, thereby making an ideal surface condition for crop growing.

After this cut-down timber land has been thoroughly swept by fire there is no more labor or expenditure in the way of land clearing or development in the making ready for planting. Not a stump, stick, or log is removed, not a cent spent for labor of any kind on the entire proposition. The land is ready for planting in first-crop corn. A gang of men, with sharpened sticks as their only implements, go over all the newly burned area, make holes promiscuously among the stumps and logs, drop the seed corn in these holes, and cover with the boot.

SHOTGUN PLANTING

When the corn begins to come up it looks as though it had in reality been planted with a shotgun. About two kernels are planted to the hole, and by not being in rows, but scattered here and there, nearly double the number of stalks can be grown upon an acre than if the land was handled by cultivation methods. Strange as the story may seem, this crude stone-age method of planting is the only labor of any kind that is expended on the crop until it is time to gather the corn in the fall. There is no cultivation of any kind, either by hand, hoe, or team work. The method is known as growing "stuck corn."

The crop is usually gathered by contract at 8 cents per bushel, from standing corn to crib. The ears are taken from the stalk in the condition known as "slip-shuck," and are cribbed with a considerable portion of the husk still remaining on the ear.

When we stop to consider that an acre of land that is in a thick timber and jungle condition one year will present to the development or owning company a full crop of corn the following year, and at a growing cost of about 10 cents per bushel for production, then the real meaning of the word wonder becomes apparent. The wonder becomes more emphatic, however, when we realize that the average selling price of this corn is at least 90 cents at the farm.

Stuck corn can be planted at a cost of from \$1 to \$2 per acre, and the crop yield will average from 40 bushels to 60 bushels per acre. There are several instances where measured acres have yielded from 75 to 100 bushels, and other solid tracts of 200 to 300 acres of stuck corn, combining all varying conditions, have yielded an average crop exceeding 50 bushels per acre.

THE RESULTS

In verification of results obtained from land development by stuck corn methods, we cite one instance where a 90-acre timber tract was fenced, ditched, cut down, burned, planted to corn, the crop gathered and cribbed, all at a total cost of \$2,748. The crop yielded 3,964 bushels of shelled corn, an average of nearly 50 bushels per acre. The net cash returns from the sale amounted to \$3,250, exceeding the entire cost of land development and operating by over \$500. After making this one crop of corn, the owner then sold the land for more than double its original purchase price. One hundred per cent, plus \$500, for a one-year investment.

Western corn growers would be unwilling to concede to North Carolina the honor of wearing the laurels for greatest per acre production in the United States, but facts are already against the West. In 1911, North Carolina had an official record yield of 226 bushels of shelled corn per acre. In 1912 one county in the drainage belt, overlooking Albemarle Sound, made the record of 223 bushels yield per acre. In 1913 one of the North Carolina Corn Club boys made the record of 192 bushels per acre, grown at a cost of only 19 cents per bushel, ranking third in world's record. Another boy's record was 187 bushels per acre, fourth in world record production at minimum cost. On my own farm at Wenona, N. C., we made a yield record of 174 bushels of shelled corn per acre at a production cost of only 12 cents per bushel. All of these quoted records are in the drainage district of Eastern North Carolina, and along the line of the Norfolk Southern Railroad.

While the characteristic location of the black soil in the Coastal Plain region is on the elevated or watershed areas, the lands lying nearer the waterways are usually of the lighter or sandy-loam type. These gray or sandy soils are also found quite extensively a little farther in, bordering the drainage territory. In some instances the gray lands are equally as level of surface as the dark soils, and are as greatly in need of thorough drainage. Wherever this drainage is installed the land proves especially valuable in the production of bright tobacco, yielding a crop that grades high in the market, and affords large yields per acre.

As evidence of these yields, the annual crop record for a part of the tobacco territory, based on a central point and within a radius of thirty miles, show

that the tobacco crop of 1914 for this territory alone yielded over 110,000,000 pounds, sold at an average of 15 cents per pound, a cash return from this limited territory amounting to \$16,500,000.

MANY PRODUCTS

But tobacco is not the only farm product sold from this territory. Within this same radius the cotton crop of last year amounted to over 150,000 bales—75,000,000 pounds, which at 10 cents per pound would amount to \$7,500,000. The cotton-seed products from this district yielded an additional \$1,500,000, making a total cotton crop farm return of \$9,000,000 for the same territory that produced \$16,500,000 worth of tobacco.

And still this is not all. The great Coastal Plain peanut territory overlaps a portion of the tobacco belt to an extent that at least another million dollars' farm crop returns can be credited to this same area. Neither must we forget that quite a portion of this area is in the potato and early trucking belt. Our farm figures must have an additional upward boost of more than \$2,000,000 as actual record returns from trucking.

We must not overlook the live stock and meat produced and sold from this same tobacco territory. Although live stock production is somewhat limited, nevertheless almost every farm sells its quota of hogs and cattle. This is especially true in the peanut producing territory. At low calculation the meat products from the tobacco farms will add a half million to our figures—and just as we begin to realize the astounding total from this little tobacco belt in the drainage district, an old hen joins in the money music with a loud cackle, reminding us that another half million in returns must be reckoned with out of respect to the hen industry.

Putting together our little column of figures, we find that the crop output from the farms in this thirty-mile radius, surrounding one common center, farm sales of tobacco, cotton, truck, peanuts, meat, and poultry products will amount to over \$30,000,000 as actual cash returns received by the farmers in a district not exceeding sixty miles square.

The crop returns as quoted only refer to a small portion of Eastern Carolina drainage. Another county, small area of about 800 square miles, produces more strawberries than any other county in the world. Another county in the drainage belt holds the world's record for the largest output of tuberose bulbs, one firm alone shipping more than two million bulbs in a single season. All this in territory that but for drainage would be of little value!

PECULIAR CHARACTERISTIC

A peculiar characteristic of the drainage lands of the Carolina Coastal Plain is their adaptability to varied crop production. The drainage farmer is not restricted to one or two staple crops, but he can as successfully grow all the products of the South, and he can outrival the northern farmer in the production of some of his few favorite specialties. We have already captured the national banner for record corn production, both in yield and cost, and other crop record banners are in easy reach.

Our tobacco farmers are all getting rich. Why not? We have records for 1914 showing where twenty acres of tobacco yielded an average of 1,200 pounds per acre, with an entire crop average selling price of 25 cents per pound, an acreage cash value of \$300, not just for one acre, but for a farm average of twenty acres. We can, and do, produce tobacco for \$50 per acre.

Cotton production in the drainage territory will double the State average yield per acre, and North Carolina ranks near the top in cotton growing average.

Peanuts represent another profitable crop, and the producing territory lies wholly in the eastern or drainage portion of the State. The average yield for an acre of peanuts is 50 bushels, weighing 22 pounds per bushel, and 3 cents will represent the average farm selling price per pound. Government statistics quote the annual peanut crop yield for North Carolina as over six million bushels, valued at over four million dollars. Peanuts are easy to grow, are not a heavy drain on the soil, and the light sandy lands bordering along the waterways are readily adapted to growing this crop.

We have referred to growing profitable crops of corn, cotton, tobacco, and peanuts. These only serve as a good heading to the list. The live-stock man, who desires heavy yields of forage crops with which to fill his silo, will find the drainage district of Eastern North Carolina an El Dorado land. Nowhere else can be grown such large yields of cowpeas and soja beans, for either hay or grain. Two crops of this forage can be grown in a single season, and on the same acre; or a crop of Irish potatoes can be grown first, to be followed by a crop of peas or beans, either for hay or seed. A single crop of this pea and bean hay will easily yield two tons per acre, selling at the farm for \$20 or more per ton. In quality this hay will rank with alfalfa, either in feed value or in preference by the animal. Where peas and beans are grown for seed, the crop is exceptionally profitable, selling as high as \$1.50 to \$2 per bushel, and yielding from 40 to 50 bushels per acre.

Western alfalfa growers claim for their crop that it can be grown on rolling or upland only. In Eastern North Carolina we are successfully growing alfalfa only four feet above sea level, six cuttings per season, and with an average total yield of five tons per acre.

A favorite green pasturage crop and one well adapted to the drainage belt is winter oats. This crop may be sown in September, used for pasturage during the winter, and with the coming of spring will make an excellent crop of either hay or grain, and can still be followed with a crop of corn or hay crop of peas or beans.

VARIED CROPS.

Staple farm products and live stock are not the only crops to which the Carolina drainage belt is adapted. Irish and sweet potatoes, cabbage, strawberries, and other like trucking crops do exceptionally well, and the quickness with which these products can be moved to the eastern city markets make trucking an attractive feature in drainage belt farming.

In connection with the great trucking possibilities of Eastern North Carolina, a frequent inquiry is why there have remained such vast areas of undeveloped lands, and why the possibilities of the section are so little known elsewhere. The query is logical, the explanation equally so—inefficient drainage and insufficient population. Only six years ago North Carolina adopted its first drainage law. Without adequate drainage the development of the greater portion of the Coastal Plain country was an impossibility.

Another fact to be borne in mind is that North Carolina had no subsidized railroads, favored with land grants, assuring earnest and profitable railroad organization efforts, to obtain settlers for this land. Furthermore, all the Southern States were so impoverished by the war that they were necessarily

slow in recovering from its effects. At the beginning of the War Between the States North Carolina had a total voting population of only 115,000, yet she contributed from her citizenship 124,000 soldiers to the Confederate Army and 9,000 to the Union Army, a total of nearly 133,000 soldiers from a voting population of only 115,000. With the close of the war over 40,000 of these soldiers were counted among the lost; nearly one-third of her citizenship. No other State, either North or South, had a condition even approaching this record. Many years were required to recover from this great loss of population handicap and to bring the State into its rightful producing power.

As a summary of results and possibilities in the way of intensive farming in the Eastern Carolina drainage belt, I might say that we are as yet only knocking at the doorway of investigation, no one mind having fathomed the measure of varied production possibilities. North Carolina was the only State in the Union able to fill every blank in the census report; the only State with a crop production so varied as to be able to furnish statistics to conform with every inquiry; the State where the apple meets the orange. North Carolina holds the grand prize cup won at the National Apple Show over all competitors, and also holds the gold medal for the best box of home-grown oranges in competition with both Florida and California.

Columbus discovered America over four hundred years ago, but the possibilities of the Old North State are only just being discovered.

MR. PRATT: I regret to say that Dr. Hill, President of the North Carolina College of Agriculture and Mechanic Arts, is unable to be with us today, but we have with us Professor M. E. Sherwin as his representative.

PROFESSOR M. E. SHERWIN, of the College of Agriculture and Mechanic Arts:

Gentlemen of the Convention:—Dr. Pratt has explained why I am here as well as I could do it myself. Before beginning my subject I wish to say that I have neither lecture nor notes. You could search me without finding any, so let us proceed to get down to the subject which I believe is put on the program as "Address."

If Dr. Hill had been able to come he would have made a good talk, one both interesting and instructive. If I had received due notice that I was to come on the program, I should have taken a subject closely related to the others we have had this afternoon. I may say a few words about tile drainage before I close.

Especially, however, I bring to the Association a message of good will from the college. Dr. Hill would have done this, and perhaps, inasmuch as I have charge of the drainage work as one division of the soils work of the college, it may be appropriate that I bring to this Drainage Convention the good will of the college and that I should tell you something of the work that we are doing. We sympathize with you in your troubles; we rejoice with you in your progress; we work with you, perhaps along slightly different lines from yours, but nevertheless we all work for the upbuilding of the lands of North Carolina by means of drainage.

The college and the Department of Agriculture may be said to be first cousins. The latter, in coöperation with the United States Department of Agriculture, maintains on its staff two men who for several years have

devoted their whole time to drainage, working out drainage systems for the farmers, calculating cost, and giving other assistance and advice where it has been needed. It was a member of the college staff who, because of demands made by the farmers for field and engineering assistance and because of the impossibility of absentsing himself from college classes, first advocated the maintaining of men in such a capacity. Whether or not this hastened the time of their coming, I am glad to say that the men have done good work. The papers which have just been presented on "Tile Drainage" reflect the quality of the work which these men have done, though most of their work has been of the field and office rather than of the literary order.

In the college we aim to give those students who take the drainage course a knowledge of the benefits and methods of drainage. The benefits they know to some extent when they come to us, but the logical reasons for the benefits they do not know; neither do they know the technique.

The information which we give them is both practical and theoretical. Not only do we stand before them and talk to them as I am talking to you now, but we take them to the field for field practice, and to the office where their field notes are worked into plans; then back to the field to put the plans into operation. We take men with no practical knowledge of drainage and make them proficient in the use of drainage levels and other drainage instruments and implements, so that when they leave college they are ready to do something for the State by means of drainage. We take the men to the ditch and teach them to dig and to grade the ditch so that they may later be able to supervise their own work or demonstrate to others. It is ever our ideal to make these men competent not only to perform the engineering features in an approved manner and to lay the tile carefully in the right manner after the ditches have been dug, but to insure by a thorough course in the principles of soils that no plans will be put in operation which will be in any way unsatisfactory. It is the knowledge making the latter possible which should distinguish our students, on the one hand, from the engineer with knowledge only of the handling of engineering instruments and maps; and on the other hand, from the laborer with knowledge only of how to dig the ditch and lay the tile after the lines have been determined for him. Here is the man that above all others will be able to do the work in the best way possible and know enough to leave undone work which would not be profitable.

There is one statement in the address of Mr. Small that I should like to use as the text for a short sermon to the Convention. That is what he said concerning the lack of confidence among the rank and file of farmers in drainage projects, good roads, etc. I realize, as Mr. Small does and as you men do, that we do not have the entire confidence of the farmers. If we did there would be more present with us today. To gain their confidence we must give them, through this Drainage Association, facts regarding the improvement of their land by means of drainage, and these facts must be given to them in a way that they can be appreciated. If we can show them that these improvements upon which we theorize can be made realities, I believe we will have their confidence.

I hope that this Association before another year will effect such an organization as to aid in bringing the farmers together in this Convention. There will be some resolutions presented to the Association in due time that, if adopted and put into operation will, we hope, interest many practical farmers

in the work of this Association and bring them to active work in its conventions.

It is time now for me to begin the subject of "Tile Drainage," if I am to speak on that subject at all, but I fear to start on such a broad subject without some definite outline to stop me. To illustrate the danger of such a proceeding—one afternoon not many weeks ago when one of my classes was scheduled for a four-hour period in the field, it began raining so that we could not go to the field. There were only the alternatives of lecturing or dismissing the class. I chose the former and lectured to the men for three and a quarter hours straight. You will hardly believe me, but the men retained their interest for that length of time. I wonder how many of you would like to have me start now on that same subject. I shall not do it, but will ask that when the proceedings of this Drainage Convention are printed, you thoroughly study the address, "Tile Drainage," by Mr. Lynde. I consider that a most admirable and timely paper.

I thank you for this opportunity of appearing before you.

MR. N. H. HARRISON, SR.:

Mr. President and Gentlemen of the Convention.—Pardon me for referring to myself a few moments. By way of criticism among people who are opposed to development of our country, I am a great apostle to drainage. They look upon it in a way of reproach, but I recognize it as an honor to myself.

There are two classes of people in the world—one is the talking kind, and the other is the working kind. The talking kind is always waiting for something to turn up—the doing kind are inspired by that zeal that will enable them to turn up something. All big things emanate from little ones. All big undertakings move slowly. Like a great stone let down from the top of the mountain, it makes slow progress at first, but it bounds and rebounds and acquires additional momentum as it rolls until it carries everything before it. At no distant day if our friends do not feel willing to fight for us in our drainage battles, we say to them, "get out of the way, for we are coming and will run right over you."

Dr. Pratt wanted me to make some report in reference to Conaby Creek District. This is located in Washington and Beaufort counties. Mr. Small held a Farmers' Educational Meeting in the courthouse of Plymouth in the month of August, 1908. Mr. J. O. Wright, of the United States Department of Agriculture, was there on that occasion. Dr. Pratt was there, and he told us of his experience in the west and that it was once a dense wilderness like ours, and how they applied their energies and made that country bloom like a rose. He filled us all up with enthusiasm. After he got through he said anyone present who wanted to ask questions was at liberty to do so. I got up and said, "Mr. Wright, my neighbors and myself have owned adjoining lands of the corporations that own this great Dismal Swamp that you have been talking about that is so fertile. There are probably 10,000 acres of land that are practically worthless in this section, perhaps with the exception of the timber that is on it, and most of the timber has been cut off, and I want you to tell us how we can develop that land unless we can get that corporation that owns the large areas of that land to cooperate with us." He said, "You cannot do it unless you can get the Legislature of North Carolina to pass a general drainage law, and then, if you possibly can get together, let there be unanimity among you and you can control this corporation and

make them help you develop that country." Mr. Gaylord, whose name has been erased from the marching of time and enrolled with the catalogue of the dead, prepared a petition and asked me to work out what is well known as the Conaby Creek Drainage District in Washington County and Beaufort County, No. 1. We went through the necessary preliminaries as the law required. The agents and the corporations said it would be better for us to serve notice on the corporations to make them parties. We did this.

The clerk wrote to Dr. Pratt to send us a United States Engineer, and he sent him. The viewers were appointed. They accompanied him. They went over that territory and made a favorable report and their findings were accepted by the clerk of the court. A final hearing was given and proper notice, and on that day not a single citizen—and there were 118 in the district—objected. It was passed, but the companies or corporations reserved the right of appeal. The commissioners were elected as the law authorized in section 442 of 1909. I was one of the commissioners appointed by the clerk of the court. I was elected chairman of that board.

In the jurisdiction of my duty and advertising the district as the law requires, the United States Engineer put me in correspondence with 118 dredge companies of the United States. I got my attorneys to notify them, stating that we had a contract to let. We had the right to reject all bids, and any bid that exceeded the estimated cost of the engineer and viewers was not to be considered. Mr. John Wilkinson put in his bid and put in a bid lower than the estimated cost. The Brett Engineering and Contracting Company also put in a bid, and we rejected all of their bids and advertised again, and at the third letting the Brett Engineering and Contracting Company was the last and lowest bidder, and they were awarded the contract for \$100,000.

The John L. Roper Lumber Company and the Roanoke Railroad Lumber Company enjoined the board from selling the bonds until they could be heard on their appeal. The Brett Engineering and Contracting Company employed Mr. Pruden and Mr. Martin to represent their interest in the courts of North Carolina. They put on the evidence that the expense would be greater than the profits, not considering the reports of the engineers and viewers and the wishes of the citizens to the number of 118 in that district. They claimed that we did not put on any evidence. Mr. Pruden claimed that the findings of that court and the evidence of the 118 owners was all the evidence that they needed before that court. The jury brought in a verdict in favor of the corporations. We appealed to the Supreme Court of North Carolina and the Court threw it out, and it leaves today a burden upon the Conaby Creek Drainage District of about \$5,000. We borrowed about \$2,000 to pay for cutting out the right of way for a distance of 38 miles. We had a meeting, and Mr. Elliott was there, Mr. Eason was there, Mr. George Boyd was there, superintending that work; and they said that if that land was ever drained that was the way it would have to be drained. Mr. Brett said after they were taken out, "Now you will have to reassess the citizens to get the money to help me cut the canal." It was more than we could stand. It was doubling their assessments, and it has been lying in that condition now for two or three years, and still this is called justice here under your Drainage Laws. At our last Convention I was in feeble health, but I wrote a letter to Dr. Pratt right before that Convention. Mr. Rice sent us word that at no distant date they would help us to develop this land. The State of North Carolina loaned us \$2,000 to pay for the preliminary

survey. The banks loaned us \$2,000, and if the corporations will not join us in paying it, our people would be much better off if Dr. Pratt and Mr. Small had not induced us to enter upon a debt of \$5,000, which is now proving a burden.

Now I would say in all good feelings to Mr. Small—and I love and revere his name as much as any man in North Carolina—we hope they are going to join us and help us to develop the country to our benefit and their benefit and the benefit of the railroads and the John L. Roper Lumber Company, so that we can take that body of 35,000 acres of land and clear down to Roper, and help us to make something out of it.

Mr. Wilkinson has not got a foot of land, and the John L. Roper Lumber Company have not any, that is better than ours, and it is just as good as any in the United States. The engineers have told me that they never struck a better piece of land in all of their work. (Darkness prevented further report of this speech.)

WEDNESDAY, DECEMBER 1

(On Board Boat to Swanquarter)

REPORTS OF COMMITTEES

COMMITTEE ON RESOLUTIONS

The people of North Carolina are to be congratulated on the splendid progress made in the drainage of the swamp and overflowed lands of the State through the operation of the North Carolina Drainage Law, which has constantly increased the wealth of the State. Looking back upon the conditions which prevailed seven or eight years ago, we are pleased to see the change of sentiment toward drainage as well as the remarkable appreciation shown toward good roads and other progressive movements of the State. We realize that all these progressive movements, particularly drainage and good roads, are mutually helpful, and that success in one must necessarily increase the efficiency of the other: Therefore, be it

Resolved, That whereas it is universally recognized that efficient drainage of the roadbed is one of the first essentials in the construction of good highways, and the work of this Association is to that extent necessarily identified with highway improvement, that an earnest invitation be extended all highway engineers and road superintendents of the State to attend the next and succeeding meetings of this Association, and the sympathetic aid of the State Highway Commission is requested to this end, and that a copy of this resolution be forwarded to the State Highway Engineer with a request that he lay same before the State Highway Commission.

Resolved, That this Association recognizes the valuable assistance of the cooperation of the Office of Public Roads and Rural Engineering of the United States Department of Agriculture, in the furtherance of the drainage movement and the organization of drainage districts since the enactment of the State Drainage Law. The detail of a representative of the Department for exclusive service in this State has been of exceedingly great value in disseminating information and making preliminary investigations as to the feasibility of drainage in many sections. This Association takes pleasure in acknowledging this obligation and in expressing its thanks to the United

States Department of Agriculture; and requests the Secretary of the Association to forward a copy of this resolution to the Secretary of Agriculture.

Resolved, That the extension of drainage, both in the organization of drainage districts and the drainage of individual farms, demands an increased number of drainage engineers competent to advise and make plans for effective drainage. This Association recognizes the instruction now offered as a part of the curriculum of the North Carolina College of Agriculture and Mechanic Arts in the various phases of drainage, but expresses the opinion that this college course may profitably be extended. This Association, therefore, recommends that the course in drainage at the North Carolina College of Agriculture and Mechanic Arts, which is preëminently the college for the teaching of agriculture, shall be so enlarged as to meet the present and future demands for the drainage of our wet lands; that the authorities of this college are invited to send as a delegate to the Annual Convention of this Association at least one representative of the student-body, pursuing the current course in drainage; that a copy of this resolution be forwarded to the president of the college, and also a copy to the president of the Agricultural Club at the college.

Resolved, That this Association go on record in expressing its appreciation of the work of the North Carolina Geological and Economic Survey, not only in forwarding the drainage and good roads work of the State, but in the development and advertisement of the natural resources of North Carolina.

Resolved, That the North Carolina Drainage Association shall have two Vice-Presidents at large, one to be charged with the interests of tile and farm drainage and the other with the interests of the district drainage of the State and in the Conventions of the North Carolina Drainage Association.

Resolved, That the North Carolina Drainage Association shall have a standing Publicity Committee of one, whose duty it shall be to coöperate with the Secretary of the Association in advertising the work and in bringing the results of drainage to the notice of the public.

Resolved, That this Convention expresses its deep regret at the death of our esteemed former member, Mr. B. E. Rice, Industrial Agent of the Norfolk Southern Railroad, and its appreciation of his faithful work in coöperation with this Association in the development of the State; and the Secretary is herewith requested to extend the condolences of this Association to the bereaved family.

Resolved, That this Association extends thanks to the city of Belhaven and its officials for the hearty welcome and support given the delegates to the Convention; to the Belhaven Board of Trade, the Board of County Commissioners of Beaufort County, to the citizens of Belhaven and Beaufort County for the warm hospitality and the many courtesies extended to our delegates, and to the newspapers of Beaufort County for advertising and reporting the Convention.

Resolved, That the thanks of this Association be extended to the Norfolk Southern Railroad for its courtesy in providing a special train for the convenience of delegates.

Resolved, That we extend to the people of Hyde County our thanks and appreciation for providing the means by which we were enabled to visit the Lake Mattamuskeet Drainage District and partake of their generous hospitality.

The report of the Committee on Resolutions was received and the resolutions were unanimously adopted.

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

We, the Committee on Nomination of Officers and Next Meeting Place, beg leave to submit our report as follows:

Place for next meeting.....Greensboro
For President.....Mr. P. H. Johnson of Pantego
For Secretary and Treasurer.....Mr. Joseph Hyde Pratt of Chapel Hill
For First Vice-President, in charge of District Drainage,
Mr. M. W. Thompson of Greensboro
For First Vice-President, in charge of Tile Drainage,
Professor M. E. Sherwin of West Raleigh

**VICE-PRESIDENTS OF NORTH CAROLINA DRAINAGE ASSOCIATION
1915-16**

<i>County</i>	<i>Name</i>	<i>Address</i>
Beaufort	J. A. Wilkinson	Belhaven, N. C.
Bertie	J. W. Cooper	Windsor, N. C.
Bladen	O. L. Clark	Clarkton, N. C.
Brunswick	J. Ed Taylor	Southport, N. C.
Cabarrus	J. Lee Crowell	Concord, N. C.
Caldwell	Dr. A. A. Kent	Lenoir, N. C.
Camden	W. G. Ferebee	Gregory, N. C.
Catawba	T. L. Hannsucker	Conover, N. C.
Carteret	Chas. S. Wallace	Morehead City, N. C.
Chowan	W. S. Privott	Edenton, N. C.
Cleveland	G. F. Hambright	Kings Mountain, N. C.
Columbus	Jos. A. Brown	Chadbourn, N. C.
Craven	R. E. Snowden	Snowden, N. C.
Cumberland	W. A. Beard	Fayetteville (R. F. D.), N. C.
Currituck	R. O. Bagley	Moyock, N. C.
Duplin	G. O. B. Parker	Chinquapin, N. C.
Edgecombe	Zeno Moore	Whitakers, N. C.
Forsyth	N. L. Cranford	Winston-Salem, N. C.
Gaston	J. F. McArver	Gastonia, N. C.
Guilford	W. C. Boren	Greensboro, N. C.
Halifax	John L. Patterson	Roanoke Rapids, N. C.
Harnett	J. C. Clifford	Dunn, N. C.
Hertford	R. L. Phelps	Ahoskie, N. C.
Hyde	D. H. Carter	Fairfield, N. C.
Iredell	Z. V. Turlington	Statesville, N. C.
Lenoir	C. W. Hodges	Kinston, N. C.
Lincoln	W. A. Graham	Lincolnton, N. C.
Mecklenburg	W. D. Alexander	Charlotte, N. C.
New Hanover	C. R. Van Leuven	Wilmington, N. C.
Orange	H. M. Berry	Chapel Hill, N. C.
Pasquotank	W. J. Cohoon	Elizabeth City, N. C.
Pender	W. A. Brown	Rocky Point, N. C.

<i>County</i>	<i>Name</i>	<i>Address</i>
Perquimans	A. R. Winslow.....	Winfall, N. C.
Pitt	J. R. Barnhill.....	Greenville, N. C.
Robeson	D. B. McNeill.....	Lumberton, N. C.
Rowan	P. H. Bernhardt.....	Salisbury, N. C.
Rutherford	W. C. McRorie.....	Rutherfordton, N. C.
Sampson	W. C. Tew.....	Huntley, N. C.
Tyrrell	E. B. Hopkins.....	Columbia, N. C.
Wake	M. E. Sherwin.....	West Raleigh, N. C.
Washington	C. W. Mengel.....	Belhaven, N. C.
Wayne	F. K. Borden, Jr.....	Goldsboro, N. C.
Wilson	J. C. Cowley.....	Wilson, N. C.

The report of the Committee on Nominations and Next Meeting Place was received and the officers were unanimously elected. The Convention also voted to hold the 1916 Convention at Greensboro.

The Committee on Membership and Credentials reported 114 delegates present, representing 19 counties, as follows:

Beaufort	Mecklenburg	Robeson
Bertie	New Hanover	Tyrrell
Currituck	Northampton	Wake
Guilford	Orange	Washington
Hertford	Pasquotank	Wayne
Hyde	Pitt	Wilson
Lenoir		

**Registered Delegates at Belhaven Convention, November 29-30,
and December 1, 1915**

Ambrose, A. W.	Creswell, N. C.
Ambrose, J. M.	Creswell, N. C.
Askew, E. S.	Windsor, N. C.
Bagley, R. O.	Moyock, N. C.
Baker, F. R.	Raleigh, N. C.
Barnhill, J. R.	Route No. 5, Greenville, N. C.
Bateman, W. M.	Plymouth, N. C.
Beckwith, Mrs. K. R.	Greenville, N. C.
Berry, Miss H. M.	Chapel Hill, N. C.
Bonner, B. T.	Aurora, N. C.
Borden, F. K., Jr.	Goldsboro, N. C.
Boschen, W. B.	Terra Ceta, N. C.
Bowen, G. W.	Surry, N. C.
Bowen, W. H.	Belhaven, N. C.
Bowen, W. R.	Route No. 1, Pinetown, N. C.
Bowen, W. W.	Route No. 1, Box 57, Pinetown, N. C.
Brinkly, D. O.	Plymouth, N. C.
Brinkley, P. W.	Plymouth, N. C.
Brinn, Charles	Swanquarter, N. C.
Brinson, W. C.	Belhaven, N. C.
Bullock, J. D.	Leechville, N. C.
Bullock, W. J.	Belhaven, N. C.
Bunn, A.	Swanquarter, N. C.
Burrus, J. C.	Fairfield, N. C.
Carter, D. H.	Fairfield, N. C.
Chappel, M. E.	Swanquarter, N. C.
Clark, J. P.	Pantego, N. C.
Cohon, C. C.	Swanquarter, N. C.
Cohon, J. F.	Leechville, N. C.
Cohon, W. J.	Elizabeth City, N. C.
Cooper, J. W.	Windsor, N. C.
Cowley, J. C.	Wilson, N. C.
Cox, D. A.	Moyock, N. C.
Cuthrell, W. W.	Belhaven, N. C.
Daniels, F. B.	Goldsboro, N. C.
Darden, D. G.	Plymouth, N. C.
Dudley, D. D.	Elizabeth City, N. C.
Edgerton, F. M.	Swanquarter, N. C.
Ellis, C. W.	Ransomville, N. C.
Gibbs, D. C.	Lake Landing, N. C.
Goldsmith, J. D.	211 W. Sixth Street, Charlotte, N. C.
Gouverneur, M. F. H.	Wilmington, N. C.
Harris, Clifford	Belhaven, N. C.
Harris, Jesse B.	Pungo, N. C.
Harrison, N. H., Sr.	Pinetown, N. C.
Hayes, — —	Charlotte, N. C.

Heckstall, W. T.	Windsor, N. C.
Herrington, Geo. W.	Ransomville, N. C.
Hodges, C. W.	(Southern Drainage and Const. Co.) Kinston, N. C.
Hopkins, E. B.	Columbia, N. C.
Hopkins, W. T.	Creswell, N. C.
House, D. E.	Greenville, N. C.
Johnson, P. H.	Pantego, N. C.
Jones, E. H.	Swanquarter, N. C.
Jones, H. C.	Fairfield, N. C.
Jones, T. B.	Fairfield, N. C.
Kirk, B. C.	Belhaven, N. C.
Latham, F. P.	Belhaven, N. C.
Latham, J. F.	Surry, N. C.
Leard, H. S.	(Norfolk Southern Railway) Norfolk, Va.
Leigh, J. A.	Belhaven, N. C.
Lynde, H. M.	Raleigh, N. C.
MacLean, A. D.	Washington, N. C.
McMullan, Harry	Washington, N. C.
McNeill, D. B.	Lumberton, N. C.
Mann, C. E.	Middletown, N. C.
Mann, Dr. H. L.	Lake Landing, N. C.
Martin, J. W.	Bethel, N. C.
Martin, Van B.	Plymouth, N. C.
Mayo, J. L.	Washington, N. C.
Mengel, C. W.	Belhaven, N. C.
Milholland, Wm.	R. F. D. 4, Norfolk, Va.
Millard, C. I.	Norfolk, Va.
Moore, Zeno	Whitakers, N. C.
Old, George	Belhaven, N. C.
Payne, Thos. S.	Ransomville, N. C.
Phelps, J. L.	Creswell, N. C.
Phelps, R. L.	Ahoskie, N. C.
Phelps, W. T.	Creswell, N. C.
Pierce, C. A.	Ahoskie, N. C.
Pierce, W. W.	Goldsboro, N. C.
Pomona Terra Cotta Co.	Pomona, N. C.
Porter, J. A.	Greensboro, N. C.
Pratt, Joseph Hyde	Chapel Hill, N. C.
Pritchard, W. S.	Windsor, N. C.
Schooley, E. E. (Contractor for Lake Mattamuskeet)	Belhaven, N. C.
Scott, W. G.	Care New First National Bank, Columbus, Ohio
Sherwin, M. E.	West Raleigh, N. C.
Small, John H.	Washington, N. C.
Snowden, R. E.	Snowden, N. C.
Spencer, C. B.	Swanquarter, N. C.
Spencer, Walter L.	Swanquarter, N. C.
Spruill, Eli D.	Creswell, N. C.
Stallings, J. B.	Fremont, N. C.
Statesbury, C. A.	(Star Route) Swanquarter, N. C.
Stillman, M. J.	Plymouth, N. C.

Swindell, G. L.....	Scranton, N. C.
Swindell, — —	Washington, D. C.
Taylor, James.....	Bethel, N. C.
Temple, N. M.....	Wenona, N. C.
Thompson, M. W.....	Greensboro, N. C.
Toland, H. A.....	Leechville, N. C.
Tooley, John G.....	Belhaven, N. C.
Tooley, Macon	Belhaven, N. C.
Tooley, W. B.....	Belhaven, N. C.
Walker, H. G.....	Creswell, N. C.
Waters, W. H.....	Dover, N. C.
Watson, W. W.....	Wysocking, N. C.
Wilkinson, G. L.....	Belhaven, N. C.
Wilkinson, J. A.....	Belhaven, N. C.
Wilkinson, Mrs. J. A.....	Belhaven, N. C.
Windley, Dr. R. E.....	Swanquarter, N. C.
Van de Carr, C. R.....	Moyock, N. C.
Van Leuven, C.....	Wilmington, N. C.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesians in Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of print.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents. Cloth copies 50 cents extra.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, 50 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

22. A Report on the Old Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, ... pp., ... pl., ... maps. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, ... pp. *Postage .. cents. In press.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

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UNITED STATES GEOLOGICAL AND MINING SURVEY
BUREAU OF PLANT GEOGRAPHY

WATERHOLE PLANT NO. 11

THE VEGETATION OF SHACKLEFORD DAM

W. M. FARRIS



WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 46

THE VEGETATION OF SHACKLEFORD BANK

BY

I. F. LEWIS



**RALEIGH
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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., June 1, 1917.

*To His Excellency, HONORABLE T. W. BICKETT,
Governor of North Carolina.*

SIR: I have the honor to submit herewith for publication as Economic Paper No. 46 a report on "The Vegetation of Shackleford Bank" by Mr. I. F. Lewis.

Respectfully,

JOSEPH HYDE PRATT,
State Geologist.

PREFACE

It has been the policy of the North Carolina Geological and Economic Survey to publish, as opportunity offered and printing funds were available, a series of reports relating to the natural history of the State.

In connection with his work at the United States Fisheries Biological Station at Beaufort, North Carolina, Mr. I. F. Lewis has made a study of the vegetation of Shackleford Banks, and it is believed that the results of this investigation will be of value not only in connection with the conservation of land areas along the coast, but will add much to the other botanical studies of the State.

In this as well as in numerous other investigations, we have had the coöperation of the United States Bureau of Fisheries.

It is expected that this report will lead to other investigations which will add more and more to the botanical history of the State.

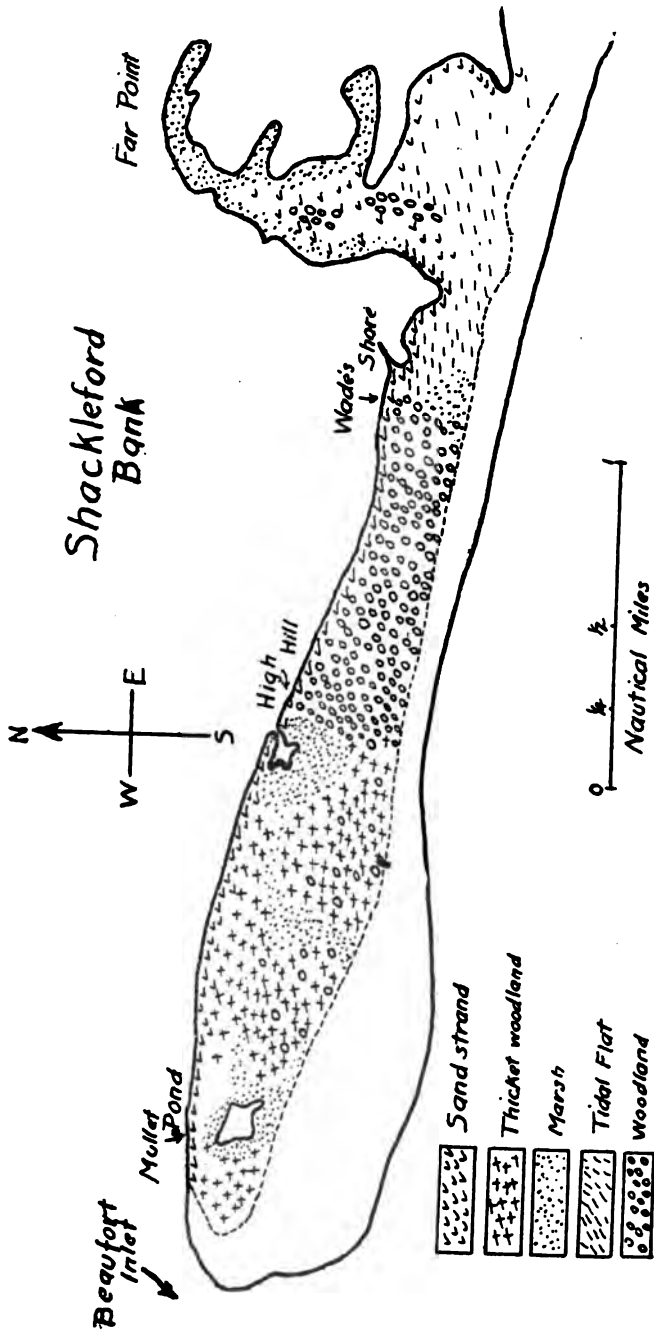
JOSEPH HYDE PRATT,
State Geologist.

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Detailed Sketch of Shackleford Bank

THE VEGETATION OF SHACKLEFORD BANK

By I. F. LEWIS.

INTRODUCTION

Shackleford Bank is the strip of land extending from Cape Lookout on the east to Beaufort Inlet on the west. It is about eight miles long and, on an average, half a mile broad. On the south it is bounded by the Atlantic Ocean, on the north by Bogue Sound. Together with Core Bank, with which it is continuous, it forms a long link in the chain of sand reefs bordering the southeastern coast of the United States.

GEOLOGY

Evidence has recently been brought forward by Cobb¹ to show that this long sand reef is essentially a part of the mainland, and that the adjoining sound may be regarded as the estuary of a river which was formerly "a southern tributary of the large river made up of the Pamlico and the Neuse."

SOILS

The soils of Shackleford may be classified under three heads: (a) A fine white marine sand, with little or no humus, is found on the outer beach, the dunes, and in places bordering the sound. (b) A gray sandy loam in the elevated central portion of the Bank. The quantity of humus in the soil varies. In places it is slight in amount, but usually it is present in sufficient quantities to form a good garden soil, capable of supporting a luxuriant vegetation. (c) In the marshes on the sound side of the bank a black mud, 1 to 2 feet deep, is found overlying a sandy substratum.

The soil water is usually 18 inches or less below the surface, and, with the exception noted below, uniformly fresh. Even where the tides cover the marshes, and water standing on the surface is salt, with a specific gravity of 1.023, the soil water is fresh. In this case the ground water probably comes up from below through the sand, the soil being too impervious to allow the surface salt water to percolate through to the fresh water below. Only in the *Spartina-Salicornia* marshes, which are constantly wet with salt water, is the ground water not fresh. Wherever plants other than *Spartina glabra (stricta)*, *Salicornia* spp. or *Borrchia frutescens* grow, the ground water is fresh.

¹Notes on the Geology of Core Bank, N. C.: Journal of the Elisha Mitchell Scientific Society, Vol. 23, No. 1. 1907.

PHYSIOGRAPHY

The elevation of Shackleford varies from sea-level in the marshes to 20-25 feet in the higher ground of the interior. Toward Cape Lookout Light are some shifting dunes perhaps 35 or 40 feet high.

The physiographic conditions on Shackleford are causing rapid changes in the vegetation of the Bank, which will be referred to later. At present it is sufficient to state that the sand of the beach is advancing on the forest at a comparatively rapid rate, destroying the vegetation in its path.

CLIMATE

The climate of Shackleford is very similar to that of Hatteras, described by Kearney.¹ From data furnished by the United States Weather Bureau for Beaufort (2 miles from Shackleford) and Hatteras, the following points of difference are taken:

The annual mean temperature of Beaufort for the last six years is 63.6° F. (17.5° C.), while that for Hatteras for the same period is 62.3° F. (16.8° C.). The maximum summer temperature of Beaufort is slightly higher (about 3° F.) than that of Hatteras, while the minimum winter temperature is slightly lower. There are practically no days at either place when the temperature does not rise as high as 43° F. (6° C.).

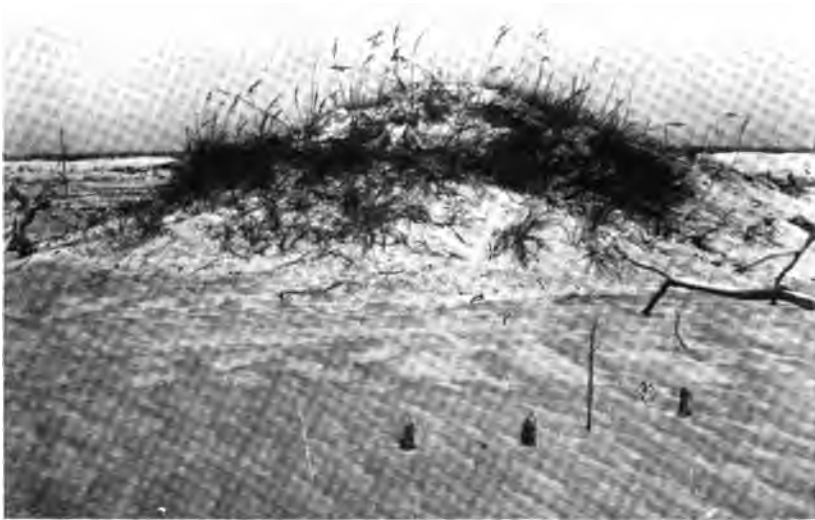
The latest killing frost in spring, and the earliest in autumn, occur at about the same time in both places (February 25 and December 13).

The amount of sunshine during the year is less at Beaufort than at Hatteras. At Beaufort the average number of rainy days during the year is 128, clear days 117, as against 118 and 204 for Hatteras. The intensity of light is greatly increased at both places by reflection from the water and the white sand, so that the actual amount of light available for the use of plants is greater than at an inland station with the same number of sunshiny days.

No data are available for determining the atmospheric humidity. The prevailing wind during the growing season is from the southwest, and is laden with moisture from the Gulf Stream, so that the average humidity is probably not less than at Hatteras, where it is notably high.

The annual rainfall is even greater at Beaufort than at Hatteras. During the years 1896-97-98 and 1906-07-08 (the only years for which data on this point are available for both stations) the average annual precipitation at Beaufort was 58.59 inches, at Hatteras 53.12 inches. However, the estimated mean annual precipitation is greater for Hat-

¹Kearney: The Plant Covering of Ocracoke Island; Contributions from the U. S. Nat. Herb., Vol. 5, No. 5. 1900.



A. Portion of the outer beach, showing a small dune built up by *Uniola paniculata*.
Around it are remnants of a destroyed forest



B. The stable barrier dune of the outer beach on Bogue Bank, formed by *Uniola paniculata*. (Photograph by R. E. Coker)

terras than for Beaufort (Hatteras 60.85 inches, Beaufort 52.55 inches).¹ These figures differ somewhat from those quoted by Kearney for Hatteras.

The precipitation is fairly uniform throughout the year. No prolonged period of drought is liable to occur.

The prevailing wind during the growing season is from the southwest. This is the wind which most affects the woody vegetation, so that the trees in exposed positions incline strongly to the northeast, the windward (southwest) side being denuded of branches, while the foliage lies mainly to leeward of the axis. Just the opposite is reported for the trees on Ocracoke.²

NOMENCLATURE

The nomenclature adopted is that of Gray's Manual of Botany, 7th edition, revised by Robinson and Fernald, and in the case of plants not listed in this work, of Small's Southern Flora.

Exact determination of the plants found is of the highest importance in such an account as this. This has been made possible by the kindness of Dr. John K. Small, of the New York Botanical Garden, to whom specimens of practically all the plants listed were sent. I wish to express here my thanks to Dr. Small for his assistance.

PLANT FORMATIONS

The plants occurring on Shackleford Bank may be arranged in the following groups:

I. Sand strand vegetation.

1. Treeless (open):

- a. Inner beach formation: *Croton-Cenchrus* association.
- b. Outer beach formation: *Salsola-Euphorbia* association.
- c. Dune formation: *Uniola paniculata* association.

2. Trees and shrubs (closed):

- a. Thicket formation: *Ilex vomitoria* association.
- b. Thicket woodland formation: *Persea-Callicarpa* association.
- c. Woodland formation: *Quercus virginiana* association.

II. Marsh vegetation.

- 1. Salt marsh formation (closed): *Spartina-Salicornia* association.
- 2. Creek marsh formation (closed): *Juncus-Eleocharis* association.
- 3. Dune marsh formation:
 - a. *Cladium-Kosteletzkya* association.
 - b. *Proserpinaca-Aspidium* association.

¹From Annual Summary, N. C. Section of Climatological Service of the U. S. Weather Bureau, 1908, p. 105.

²Kearney, l. c., pp. 266, 271. I am informed by Mr. W. B. Longest of Beaufort, who has visited Ocracoke daily for some years, that Kearney is in error as to this matter. Mr. Longest states that at Ocracoke, as elsewhere on our coast, the trees are most affected by the summer winds (off the sea), and that the axes of the trees incline toward the North.

c. *Isnardia-Pluchea* association.

d. *Acorus-Saltz* association.

4. Tidal flat formation (closed): *Scirpus-Paspalum* association.

I. SAND STRAND VEGETATION.

1. TREELESS (OPEN).

a. INNER BEACH FORMATION.

This formation fringes the sound side of Shackleford except in a few places where the salt marsh extends to the water's edge. The soil is a fine sand, bare of vegetation up to the limits of mean high tide. Above this limit *Spartina patens*, *Cenchrus tribuloides*, and *Croton maritimus*, all perennial species, occur commonly, though not covering the ground completely. *Chenopodium Botrys*, *Physalis viscosa*, and *Salsola Kali* are of common, though not universal, occurrence.

b. OUTER BEACH FORMATION.

The sandy soil is mixed with broken fragments of shells. The soil water stands at a depth of about 12 inches, and is fresh. The outer beach is overrun by the highest winter tides, but is above the mean high-tide line.

The vegetation is sparse and open, the individual plants standing at wide intervals. The loose character of the soil imparts a desert aspect to the vegetation. *Salsola Kali*, *Euphorbia polygonifolia*, and *Amaranthus pumilus* are characteristic of this formation. *Fimbristylis castanea* and *Spartina juncea* (*patens*) occur occasionally.

c. DUNE FORMATION.

The sand accumulated on the dunes is wind-blown and of fine texture. The soil water is fresh and stands at a depth of 18-24 inches.

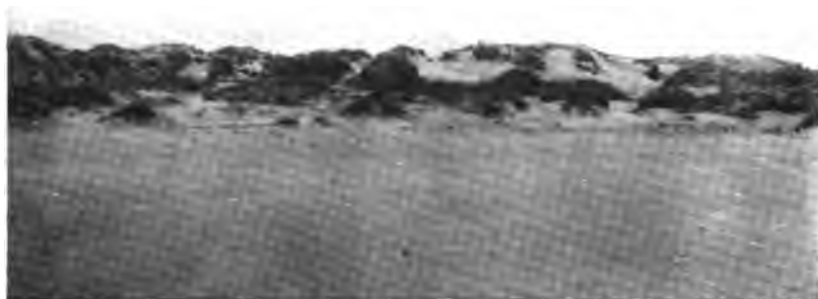
The dunes are covered with *Uniola paniculata*, whose flowering stalks, sent up in abundance, are very striking. This species appears to set seed rarely in this locality. Besides the *Uniola*, *Physalis viscosa*, *Croton punctatus*, *Solidago sempervirens*, and *Oenothera humifusa* are present. This formation reaches its best development on the neighboring Bogue Bank. (See Plates II A and B and Plate III A.)

2. TREES AND SHRUBS.

a. THICKET FORMATION.

The soil is sandy, with a slight admixture of humus. Owing to its being completely shaded, it dries out much less readily than the open sandy soil of the preceding formations.

Ilex vomitoria, from a few inches to 3 feet high, covers the ground so closely that one can with difficulty make his way through the thickets. Where a break occurs in the vegetation, *Ilex opaca*, *Juniperus virginiana*, *Smilax Bona-nox*, *Myrica carolinensis*, and other species occur.



A. Face view of the barrier dune on Bogue Bank



B. View of thicket woodland and marsh, taken from the sand wall



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b. THICKET WOODLAND FORMATION.

The soil here is a light sandy loam. The vegetation is very dense and consists of a large number of species of trees, shrubs, herbs, and woody vines. The trees commonly occurring are *Persea pubescens*, *Quercus nigra*, *Osmanthus americanus*, *Pinus taeda*, and *Juniperus virginiana*. Of shrubs the most striking are *Ilex vomitoria*, *Myrica cerifera*, *Callicarpa americana*, *Ilex glabra*, and *Sabal glabra*. Characteristic herbs are *Asplenium platyneuron*, *Anychistrum Baldwinii*, *Lechea villosa*, *Hieracium Gronovii*, *Elephantopus nudatus*, *Acalypha gracilens*, *Ascyrum hypericoides*, *Galactia volubilis*, *Desmodium paniculatum*, and species of *Panicum*. Woody vines are very conspicuous. *Berchemia scandens*, *Smilax Bona-nor*, *S. laurifolia*, *Vitis rotundifolia*, and *Psedera* (*Parthenocissus*) *quinquefolia* are most abundant. (See Plate III B and Plate IV A and B.)

c. WOODLAND FORMATION.

On all the higher parts of the island except the dunes, the soil is a deep light sandy loam. On this trees reach a considerable size. The vegetation is much less dense than that of the previously described thicket woodland. Common trees are *Quercus virginiana*, *Carpinus caroliniana*, *Ilex opaca*, *Morus rubra*, and *Quercus phellos* (*laurifolia*). *Ilex vomitoria* and *Zanthoxylum Clava-Herculis* occur commonly as well developed shrubs. The characteristic herbs are *Stipa avenacea*, *Uniola laxa*, *Jatropha stimulosa*, and *Eustachys petraea*. Woody vines, while of common occurrence, are less conspicuous than in the thicket woodland formation. (See Plate V A.)

II. MARSH VEGETATION.

1. SALT MARSH FORMATION.

This formation occurs commonly along the border of the sound. The soil is a blackish mud about 2 feet deep, very impenetrable to surface water. The surface is usually covered with salt water at high tide, yet the soil water, about 12 inches below the surface, may remain perfectly fresh.

The only plants occurring always in this formation are *Spartina glabra* (*stricta*), *Salicornia ambigua*, and occasionally *Borrichia frutescens*. At one point opposite Cape Lookout *Salicornia mucronata* (*Bigelowii*) replaces the elsewhere universal *S. ambigua*. On the next Bank to the north, Ocracoke Island, Kearney¹ reports, in a similar formation, *Salicornia europaea* (*herbacea*) associated with *Spartina stricta* (*glabra*). (See Plate V B.)

¹Kearney, l. c.

2. CREEK MARSH FORMATION.

The conditions of soil and soil water are the same as in the preceding formation. The creek-marsh formation is not, however, covered at mean high tide.

The characteristic plants of this formation are *Juncus Roemerianus*, *Scutellaria palustris*, and *Eleocharis albida*. Abundant are *Scirpus americanus*, *Gerardia maritima*, *Fimbristylis castanea*. (See Plate VI A and B.)

3. DUNE MARSH FORMATION.

The soil is dark as in the salt marsh formation, but is not reached even by winter high tides and the surface water is therefore fresh.

a. Where the drainage is good, the surface water running into small creeks which make their way to the sound, occurs a rich plant covering characteristic of which are *Cladium jamaicense*, *Kosteletzkya virginica*; abundant are *Boehmeria cylindrica*, *Cyperus strigosus*, *Ipomoea sagittata*, *Lippia nodiflora*, *Bacopa Monniera*, (*Monniera Monniera*), *Ammania Koehnei*, *Dichromena colorata*.

b. Where the marsh is inclosed on all sides by neighboring high ground, the drainage is very poor. As already mentioned, the black soil is very impenetrable, and the surface water stands almost indefinitely, becoming dark brown in color. Here *Ludwigia palustris*, *Pluchea foetida*, *P. camphorata*, and *Cyperus haspan* are the characteristic species.

c. In a few places such a poorly drained area seems liable to be covered by the highest winter tides. Here *Proserpinaca pectinata* and *Aspidium Thelypteris* dominate the vegetation.

d. In the lee of the highest dunes near the eastern end of the Bank are permanent pools (1-3 feet deep) where *Acorus Calamus* and *Salix* sp. are common. Around these pools occur many of the species noted above. (See Plate VII A and B.)

4. TIDAL FLAT FORMATION.

This occurs wherever an area originally occupied by the dune marsh has become sanded over. The soil is a mixture of the mud of the swamp and the sand which has drifted in. The characteristic association is made up of dwarfed *Scirpus americanus*, 6-8 inches high, and of *Paspalum distichum*. *Fimbristylis castanea* and *Spartina patens* are often met with. All of these are plants at home in the marshes. Besides them, *Euphorbia polygonifolia* and *Cenchrus tribuloides* occur as invaders from the sand strand.



A. Thicket woodland. The trees, *Juniperus virginiana*, and the woody vines, *Berchemia scandens*



B. Dune marsh and thicket woodland



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GENERAL ACCOUNT OF SHACKLEFORD VEGETATION

The western end of the island presents a sandy shore both to the sea and to the sound. The sand strand vegetation on the sound side is formed of scattered specimens, only a few species being represented. The most characteristic are *Spartina patens*, *Cenchrus tribuloides*, and *Croton punctatus*. About twenty other species, both annual and perennial, occur occasionally or commonly with these. The majority are either halophytic or pronouncedly xerophytic. The vegetation, like that of the outer beach, is desert-like and unattractive.

Leaving the sound, the strand rises a few feet and passes into the higher ground in the center of the Bank. Here the knolls, of loose sandy texture, are occupied by a thicket vegetation, while in the hollows are swampy areas, with the soil black mud, on which flourishes a luxuriant herbaceous vegetation.

Passing through this area toward the sea one comes on an advancing sand wall, 10 to 20 feet high, which is burying the vegetation at a rapid rate.¹ On the sandy plateau south of this some cedars still stand, the alburnum eaten away by the driving sand, the heart-wood sound. Some of these trees have been uprooted and lie almost completely buried. Others are upright, the topmost branches alone showing above the sand. On those dead cedars which are not covered by the sand are frequently to be found masses of lianas, their leafy crowns replacing those of the dead trees exactly, so that in the distance the trees seem to be living. One such dead *Juniperus* bore five lianas, forming a dense mat where the crown of the tree was, and rooting in the sand. The soil water at this point was 18 inches below the surface and quite fresh. The usual woody vines growing on these outposts of vegetation are *Psedera* (*Parthenocissus*) *quinquefolia*, *Vitis rotundifolia*, *Cissus arborea*, *Rhus radicans*, and *Berchemia scandens*.

Besides these remnants of a once vigorous forest growth, there are present on the sandy plateau between the thickets and the sea only a few scattered specimens of the species usual on the outer beach. The shifting soil is no doubt responsible for the sparseness of living vegetation in this portion of the island. At one point, near the western end, a few small dunes have been built up by the growth of the sea oats (*Uniola*).² The dunes are low and dome-shaped. Since they are isolated from one another, they do not form a barrier between the outer sand and the inner thickets, as is the case on the neighboring Bogue Bank.³ They are growing and spreading, however, and in time, if left undisturbed, will afford some protection to the vegetation at this end of the Bank.

¹Figs. 4, 6, 11, 12.

²Fig. 1.

³Figs. 2, 3.

The interior of this portion of the island is covered by a very dense vegetation, through which it is difficult to force a passage. The lower ground possesses a black, impervious soil, constantly wet with rain-water, and covered by a dense herbaceous growth. Around these fresh-water swamps the sandy elevations are covered with shrubs and small trees.¹ Woody vines are especially abundant here, growing with a tropical luxuriance which contrasts strangely with the desert-like aspect of the beach formations.²

Between High Hill and Mullet Pond (see map) the sound is bordered by salt marshes, which are overflowed at high tide. The vegetation here is constant in character and appearance. A dense stand of *Spartina glabra*, in which *Salicornia ambigua* is abundant, gives the marshes a uniform grassy appearance. This association is invaded rarely, and then only by *Borrchia frutescens*.

Above the level of ordinary high tides the marsh is given a more varied aspect by the presence of a number of invading species. Of these, *Juncus Roemerianus* is one of the first to appear. This is a large, tall rush, the dark clumps of which dot the marshes here and there. Climbing on the rush is usually to be found a narrow-leaved, slender herb, *Seutera palustris*. Between the hummocks of *Juncus* occurs commonly *Gerardia maritima*, forming purple patches on the level swamp.

East of High Hill the ground is uniformly high, from 10 to 20 feet above sea-level, and the sand strand is quite narrow. In this stretch occurs open woodland, where the vegetation is not so dense as in the thicket woodland farther west. The characteristic trees are *Quercus virginiana*, *Q. phellos*, *Persea pubescens*, *Morus rubra*, and *Ilex opaca*. While some of these trees are of considerable size, none of them attain the dimensions of the same species on the less exposed mainland. Between them *Ilex vomitoria* (yaupon) is the usual shrub, here being beset with numerous short thorn-like branches. Woody vines are conspicuous, the species being identical with those mentioned as occurring occasionally on the sandy plateau bordering the sea beach.³

At about the level of Wade's Shore the open woodland begins to be succeeded by dune marshes. Here the black soil retains the rain-water, which stands at a level of 6-12 inches, and which is brown in color like the "Juniper water" of the Dismal Swamp. These marshes are not of great extent and lie on the seaward side, near the wall of advancing sand.

From this point to Cape Lookout both forest and swamp have disappeared completely save for one or two small groves of live oak, which

¹Fig. 4.

²Fig. 5.

³Fig. 7.



A. Open woodland, the sand drifting in to the right. *Quercus virginiana* and *Juniperus virginiana*



B. Salt marshes (*Spartina* and *Salicornia*) near the Fisheries Laboratory
(Photo by R. E. Coker)

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have been able to resist the advancing sand. Elsewhere this portion of the island is a sandy waste, with little or no vegetation, except that in the lower places may be seen evidences of the swamps that existed here before the advancing sand covered the island from the sea to the sound. In such low flat areas *Scirpus americanus* and *Fimbristylis castanea*, most tolerant of sand and drought of all the marsh species, continue to exist side by side with *Croton punctatus*, *Salsola Kali*, and *Cenchrus tribuloides*, plants at home on the sand strand. *Paspalum distichum* often covers the ground with a weak but uniform turf in such spots, and *Spartina patens* is usually present.

The sand strand also does not extend east of Wade's Shore, but gives way to the flat salt marshes, which border the sound.

Not far from Cape Lookout, about 400 yards from the sea, are dunes some 40 feet high. In the lee of these are fresh pools, fed by seepage from the dunes. *Acorus Calamus* and *Salix sp.* are here present, while around the pools are the shrubs of the thicket formation occurring toward the western end of the island.

THE VEGETATION OF BOGUE BANK

On this bank, which extends west from Beaufort Inlet, physiographic conditions have produced a much more stable configuration than on Shackleford. A line of dunes about 20 feet high, formed and covered by sea-oats (*Uniola*) extends along the bank, and protects the vegetation in its lee from the encroachments of drifting sand. Back of the dunes on the eastern end of the bank for a distance of about five miles the ground is covered by thickets somewhat like those described for Shackleford, though the woody plants are here smaller and more shrubby. *Ilex vomitoria* is the dominant shrub, while *Zanthoxylum Clava-Herculis* and *Juniperus virginiana* are common. In the more open places are the herbs and shrubs characteristic of similar localities on Shackleford.

From about five miles west of the Inlet, the Hoop Pole woods cover the bank, the beach being here quite narrow. The woods are protected by a barrier dune, or sand wall, held in place by *Uniola* and various sand-binding herbs and shrubs, among which a low form of *Ilex vomitoria* is abundant. The Hoop Pole woods themselves are composed mostly of hardwood trees of considerable size, with an admixture of pines and cypresses. The forest here is quite similar to that of the adjacent mainland, and here flourish many plants which cannot endure the severer conditions on Shackleford. Botanically, Bogue Bank from Bogue Inlet to the eastern end of the Hoop Pole woods (about 20 miles) is a continuation of the mainland.

CONSERVATION OF THE VEGETATION

The vegetation of Shackleford Bank is described at some length because of the rapid changes in the physiography of the region now taking place. In the memory of living inhabitants, the Bank was well wooded over its entire extent, the strand separating the forest from the ocean beach being so narrow that it was "possible to sit in a tree and cast a fishing line into the water." Before the Civil War, however, cutting of timber, coupled with forest fires, the grazing of cattle and sheep, and the inroads of gales, had broken the protecting wall of vegetation and allowed the sand from the beach to blow in on the trees. Slowly at first, and then more and more rapidly, the sand was blown in on the vegetation, killing or covering the existing plants. At the present time the forest east of Wade's Shore (see map) has been destroyed, and this portion of the Bank is a sandy waste, with here and there a wind-blown dune sheltering a remnant of the former vegetation. In the western and wider portion of the Bank the progress of the sand has been slower, and perhaps half of the original plant covering remains. Here the work of destruction is going on at a rapid rate. The dry sand, blowing over the wide beach, is carried to the edge of the forest and there falls over a slope of an angle of about 30° . This sloping sand-wall is advancing on the forest at a rate of 4 to 12 feet a year and killing all vegetation in its path. As the beach broadens, the sand will drift in with increasing rapidity, until within a comparatively few years the forest-covering will be obliterated.

The results of this will be twofold. It will probably lead to the abandonment of Shackleford Bank as a permanent place of residence, because without the protection afforded by the vegetation, the winter storms will sweep over the land with such force as to make residence unsafe. In the second place, the sand will continue to drift north with increasing rapidity, and this will have a tendency to fill in the rather narrow sound lying between the bank and the mainland. The hindrance thus caused will be slight, because few boats now pass this way, the channel being tortuous and in places quite shallow. Of more importance will be the effect of the closing of the channel on the fisheries of the region. The enormous number of mullet and other fish now coming through Core Sound to Beaufort Inlet would pretty certainly be diverted to some other inlet farther northeast. Whether this would result in a diminution of the total catch of Pamlico and Core sounds, or whether the loss at one point would be compensated for by a gain at another, cannot be stated. At any rate there would be a serious disturbance to the conditions which now make fishing profitable in this region.



A. Creek marsh and thicket woodland



B. Creek marsh and thicket woodland

For these two practical reasons, then, it seems desirable to protect the existing vegetation of Shackleford from further destruction by drifting sand. A third reason is not less important. From Cape Henry southward along our entire Atlantic Coast similar conditions are met with. What are now forest lands, some quite valuable, are being converted into sandy wastes. The methods which have proved successful in other parts of the world¹ in controlling shifting sands and converting them into forest lands have never been tried in this section to any extent, and it would be of practical and scientific value to conduct experiments along this line on Shackleford Bank. The area to be protected is rather small, so the cost of the experiments would not be very great.

The first step in such reclamation and conservation work would be the production of a barrier dune running along the sea beach similar to that employed on the Kurische Nehrung in Germany and on the southwestern coast of France. The first step in the formation of such a dune would be to form a long ridge of sand, 10-12 feet high, by means of a brush fence. This should consist of two rows of rough stakes or untrimmed branches, driven firmly into the sand and projecting two or more feet above the surface. Such a fence should be set 100 feet from the sea. It would cause the drifting sand to accumulate in a long ridge. When the ridge becomes 10 or 12 feet high, sea oats (*Uniola paniculata*) should be set out after the manner used in other countries in transplanting the sea marram (*Ammophila arenaria*). With some attention a barrier dune would be thus formed similar to that now protecting the Hoop Pole woods on the neighboring Bogue Bank.

After the barrier dune is formed, the region back of it, now a sandy plateau, should be planted in loblolly pine (*Pinus taeda*). The work of reclamation would then be complete, and occasional attention to the barrier dune, with the purpose of repairing accidental breaks due to storms, and preventing blow-outs, would make it permanent.

If the barrier dune is once formed, the work of reclaiming the sandy plateau would be greatly aided by various native plants. Of these the most important are *Spartina juncea*, *Fimbristylis castanea*, *Physalis viscosa*, and *Paspalum distichum*. *Ilex vomitoria*, which seeds very freely, would aid materially in providing a windbreak for the young pines. All the plants mentioned are valuable sand binders, since they have long branching roots or rhizomes which tend to hold the sand. Occasional clumps of *Salsola Kali*, *Cenchrus tribuloides*, *Oenothera humifusa*, *Euphorbia polygonifolia*, and *Solidago sempervirens* would also occur on such a formation, but would be of less importance because their roots strike vertically, rather than horizontally, into the sand.

¹Hitchcock, A. S., Methods used for controlling and reclaiming sand dunes: Bull. 57, Bureau of Plant Industry.

The entire strip involved in such an experiment as that suggested is about three miles long. The cost of building the brush fence cannot be stated with certainty, but would be in the neighborhood of \$500, while planting the sea oats would cost perhaps \$200 more.¹ The ultimate success of the operations would depend very largely on having a competent man to inspect the barrier dune occasionally, say once a month, and repair breaks by means of sand fences.

The prohibitive cost of the reclamation operations suggested by Bond² is estimated from his study of the conditions obtaining at Hatteras. The actual cost of reclamation work on Shackleford would be less than estimated by Bond, for the following reasons: (1) The fence need not be of board, since experience in other localities proves that sand is held sufficiently well by a rough fence or hedge built of untrimmed branches driven into the sand. (2) The sand ridge need not be built up to the height of 30 feet, as recommended by Bond. After the ridge has been raised 6 feet or so from the level of the beach, sea oats should be planted. This species, by its natural growth, would build up the ridge to the desired height.

These two matters are mentioned to show that the estimates of Bond were made without sufficient regard to the local conditions. His recommendations are taken from Hitchcock's paper (l. c.) on Controlling and Reclaiming Sand Dunes, which is based on a study of the methods used in the "Netherlands, Denmark, Germany, and France" (p. 5). These methods, to be successful on our coasts, must be adapted to local conditions, and a study of these conditions must precede successful reclamation work. The results of such a study I have endeavored to include in the present account.

SAND AND SOIL BINDING PLANTS AND THEIR ACTIONS

The character of the soil around Beaufort is such that physiographic agencies act rapidly. The sandy shoals in the sound, and therefore the channels, are constantly being shifted by tidal currents. The sands of the "banks" are extremely unstable, and are continually being moved about by the wind. There are certain natural agencies, however, which tend to check this extensive movement of the soil, and which must be the basis of any permanent fixation of the land. These are the work of sand and soil binding plants, somewhat similar to but not identical with the plants of the same function in other parts of the world.³

A brief account of these plants and their action will be given here.

¹These estimates were made in 1909, and must be modified on account of the great increase in the cost of labor.

²Biennial Report of the State Geologist, N. C. Geological and Economic Survey, pp. 42-43, Raleigh, 1903.

³See Hitchcock, l. c.



A. Dune marsh and thicket woodland; on the right the advancing sand wall



B. View from the sand wall across the island to the sound



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SOIL-BUILDING PLANTS

The most important are *Spartina glabra*, *Salicornia ambigua*, and *Borrchia frutescens*. These are plants of the salt-marsh, and live only in situations where the soil is flooded at high tide, and where the water is comparatively quiet. They are an important factor in the formation of the numerous flat, marshy islands lying in Bogue Sound and around the mouth of Newport River. At first, sandy flats, quite bare of vegetation, are formed by the currents due to wind and tide. *Spartina* may gain a precarious foothold on the loose sand. It then sends its strong, thick rhizomes here and there, binding the sand on which it grows, adding humus, collecting and holding silt brought down by the rivers. In such situations the grass is stunted and sparse, but by thrusting a spade into the sand one sees that the substratum is closely occupied by the long heavy branching rhizomes long before the conditions are sufficiently favorable for the aerial part of the plant to send up its flowering stalks or even to produce very vigorous foliage. At this stage *Salicornia ambigua* may also gain a foothold and aid in reclaiming the sandy wastes. The building up is accomplished partly by the plants catching and holding the sand and silt brought to them by the currents and partly by the actual addition of dead and rotted plant substance. After these forces have been at work for some time the land may be raised nearly or quite out of reach of high tides, and invaders begin to appear in the highest ground and help build it up further. The common invaders in such situations are *Borrchia frutescens*, *Limonium carolinianum*, *Solidago sempervirens*, *Strophostyles umbellata*, *Iva oraria*, and *Spartina patens*.

All stages of this island-formation can be observed near the Fisheries Laboratory. On Shark Shoal¹ south of the Laboratory, the *Spartina* has just been established. To the north are broad flats of marsh with *Spartina*, *Salicornia*, and *Borrchia*. Where the currents of the water have aided in building up the land the other species mentioned above are to be seen. The town marsh is in a still later stage of development; woody species such as *Myrica cerifera*, and various grasses and herbs, have appeared.

Changes in the small islands of the sound are not all progressive. When the direction of the tidal currents is changed for any reason, the result may be the denudation of land already built up. Such denudation has occurred in a striking way on Bird Shoal, just south of the town of Beaufort. This island was, twenty years or so ago, of an elevation of 15 or 20 feet, and covered with a vigorous growth of plants,

¹*Spartina* has also been planted on Shark Shoal.

including sea oats (*Uniola*), *Myrica cerifera*, and many other species both shrubby and herbaceous. The action of storms, however, combined with changes in the direction of the tidal currents, has resulted in leveling this land until it is now completely covered at mean high tide. The only vegetation now occurring here is a sparse growth of *Spartina glabra*.

Another method of island-formation in neighboring waters has been described by Grave.¹

SAND-BINDING PLANTS

Methods for controlling and reclaiming shifting sands have been well worked out in other regions, and it is known with tolerable certainty just what may be expected of any species of sand-binding plants under given conditions. These conditions are the same the world over. High winds playing over dry sand furnish conditions for plant life that call for specially modified species to withstand them.

In controlling shifting sand, the first step is usually the formation of a barrier dune which will catch and break the full force of the wind; second, the sand back of the dune must be held in place until it can be forested; third, the forest must become established in the lee of the barrier dune.

For forming the barrier dune, beach grass (*Ammophila arenaria*) has been almost universally used. This species is not available at Beaufort. Its place is well supplied, however, by the sea oats (*Uniola paniculata*), which possesses all the features that make beach grass valuable in other localities. Its leaves are sufficiently tough to resist the action of blasts of dry sand driven at high speed. They are too flexible to be broken by direct action of the wind. The root-stocks are strong, heavy, and branching, and strike both vertically and obliquely into the sand, so that the plant is securely anchored, and the sand firmly held. Lastly, the constant movement of the sand is rather beneficial than injurious to *Uniola*.

That this species may be successfully used in forming a barrier dune is evidenced by Bogue Bank in the neighborhood of the Hoop Pole wood. Here the dune is stable, and furnishes complete protection to the forest.

The sea oats will prove most valuable in controlling shifting sand. It is not available, however, for reclaiming sandy wastes, for the reason that it flourishes only where the sand is constantly moving. Where the sand, sheltered by a barrier dune, is comparatively stable, other species

¹Grave, C., Investigations for the Promotion of the Oyster Industry in North Carolina; U. S. Fish Commission Report, pp. 260-264. 1903.



A. Sand wall advancing on woodland



B. "Graveyard" of forest, some of the dead trees covered with lianas

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are required to hold it in place and, by the addition of humus, to furnish the conditions necessary for a permanent plant covering. Of these species, by far the most valuable in this locality are *Spartina patens* (*S. juncea*) and *Physalis viscosa*. The latter possesses the toughness of leaf necessary to resist the driving particles of sand, and has, in addition, very long, slender, tough, branching root-stocks, which are admirably adapted to hold in place the sand throughout a considerable area around each individual plant. In one plant one of the root-stocks, not including the branches, was found to be upwards of 45 feet in length. Furthermore, *Physalis* is a perennial plant which sets seed freely. *Spartina patens* possesses the same advantages, although the root-stocks are not so long, and is, in addition, more able to resist adverse conditions. The other species which flourish on more or less unstable sand, such as *Euphorbia polygonifolia*, *Croton punctatus*, *Cenchrus tribuloides*, and others, are not so valuable as sand binders, because they lack the extensive branching root-stocks of the two species mentioned first, and because the majority (*Croton punctatus* is an exception to this rule) are annual plants, which are useful only in the summer. One shrubby plant, *Iva oraria*, would prove valuable if it could endure the severe conditions obtaining on sandy areas exposed to the full sweep of the wind; this has not yet been demonstrated. Figure X, *B*, shows this species forming a stable dune where it is somewhat protected from the wind. Another, *Ilex vomitoria*, is an efficient sand binder and an excellent windbreak when it once gets a foothold. It is difficult to transplant, however, and it is somewhat doubtful whether it would grow from seed in exposed sandy localities. If any reclamation operations are undertaken, efforts should be made to establish it on the exposed sand.

GEOGRAPHICAL DISTRIBUTION OF SHACKLEFORD PLANTS

The entire chain of sandbanks along the North Carolina coast lies in the Austro-riparian area of the Lower Austral Zone.¹ This area includes the coast region beginning from the mouth of the Chesapeake Bay and the coastal plain region of the South Atlantic and Gulf States from North Carolina to Texas, with the exception of the southern extremity of Florida. An analysis of the flora of Shackleford shows the Austro-riparian element to be dominant at this place. Over 24 per cent of the total number of plants listed are characteristic of the flora of this area. These are as follows:

¹See Merriam, The Geographical Distribution of Animals and Plants in North America: Year Book, U. S. Department of Agriculture, 1894, pp. 203-214. Also, Life Zones and Crop Zones of the United States, Bull. 10, Biol. Survey. 1898.

1. Maritime species:

<i>Borrchia frutescens</i> ‡ *	<i>Seutera (Vincetoxicum) palustris</i> † *
<i>Croton punctatus</i> † *	<i>Suaeda (Dondia) linearis</i> † *
<i>Cyperus tetragonus</i> †	<i>Uniola paniculata</i> † *
<i>Eustachys petraea</i> † *	<i>Yucca aloifolia</i> † *
<i>Heliotropium curassivicum</i> † *	—
<i>Physalis viscosa</i> † *	10

2. Species normally occurring near the coast:

<i>Berchemia scandens</i> †	<i>Laurocerasus caroliniana</i> †
<i>Callicarpa americana</i> †	<i>Lyonia (Pieris) nitida</i> † *
<i>Cicuta curtissii</i> †	<i>Osmanthus americanus</i> †
<i>Cissus (Ampelopsis) arborea</i> † *	<i>Panicum lancearium</i> †
<i>Cyperus haspan</i> † *	<i>Paspalum distichum</i> † *
<i>Cyperus microdontus</i> † *	<i>Persea borbonia</i> †
<i>Fimbristylis spadicea</i> † *	<i>Persea pubescens</i> †
<i>Gaura angustifolia</i> †	<i>Quercus virginiana</i> † *
<i>Gelsemium sempervirens</i> †	<i>Rubus trivialis</i> †
<i>Ilex vomitoria</i> †	<i>Sacciolepis striata</i> † *
<i>Ipomoea sagittata</i> † *	<i>Solanum gracile</i> † *
<i>Iva imbricata</i> † *	<i>Vincetoxicum suberosum</i> †
<i>Jatropha stimulosus</i> †	<i>Zanthoxylum Clava-Herculis</i> † *
<i>Kneiffia arenicola</i> †	—
<i>Ludvigia alata</i> †	29
<i>Ludvigia microcarpa</i> †	

3. Species occurring normally on the costal plain:

<i>Arenaria lanuginosa</i> † *	<i>Ludvigia virgata</i> †
<i>Cladium jamaicense</i> † *	<i>Paspalum laeve australe</i> †
<i>Commelina angustifolia</i> †	<i>Passiflora incarnata</i> † *
<i>Croton glandulosus</i> † *	<i>Polygonum setaceum</i> †
<i>Cynoctonum mitreola</i> † *	<i>Sporobolus indicus</i> † *
<i>Dichromena latifolia</i> †	<i>Stenophyllus stenophyllus</i> †
<i>Eleocharis ochreatea</i> † *	<i>Vaccinium arboreum</i> †
<i>Eupatorium capillifolium</i> † *	—
<i>Juncus megacephalus</i> †	16

Total number of strictly Austro-riparian species occurring on Shackleford, 55.

To this list may be added ten species which are stated by Small not to occur north of South Carolina. The ranges quoted are taken from Small's Southern Flora. These species are:

- Andropogon tetrastachyus* ("South Carolina to Florida and California").
- Anychiastrum Baldwinii* ("Georgia to Louisiana and Florida").
- **Eleocharis microcarpa* ("Florida to Louisiana. Also in Cuba").
- **Lagenaria vulgaris* ("Gulf States and throughout the Tropics").

*Also in tropics.

†Northern limit North Carolina.

‡Northern limit Virginia.



A. Dead *Juniperus* covered with lianas



B. View of High Hill from the sound, showing the rise of the land at this point



- Lippia nodiflora* ("Georgia to Florida").
Paspalum floridanum ("South Carolina to Florida, west to Texas").
Rubus persistens ("South Carolina to Florida and Mississippi").
Rynchospora stipitata ("In river swamps, Florida").
Sabal glabra ("South Carolina to Florida and Louisiana").
**Verbena polystachya* ("Florida, through the Gulf States to California").

Spiranthes ovalis has also not been reported from this State. *Festuca rubra* ranges from Labrador to Virginia, mostly near the coast.

Of the species listed which are not confined to the Austro-riparian area, 27 are maritime and 28 usually occur along the coast. The northern limits of these species are from Nova Scotia to Maryland. With few exceptions they range all along the shores of the South Atlantic and Gulf States.

Of the remaining species, the great majority are weeds of wide distribution, and not confined to or characteristic of any one phytogeographical area. Of these, 137 range practically throughout the United States except on the Pacific slope, while 21 occur throughout the Carolinian and Austro-riparian areas. Leaving out of consideration these species and the wide-ranging strand-forms, it is seen that the flora of Shackleford is almost typically Austro-riparian in its character. The absence of many forms usually occurring in this area¹ is to be attributed, no doubt, to the severe conditions for plant life on the sand banks, since these species are abundant on the mainland, only one to two miles away.

It is worthy of note that the species found also in more northern areas which extend as far south as Beaufort, usually extend also throughout the Austro-riparian area to Florida and the Gulf States. There are only ten exceptions to this rule, or 3 per cent of the whole. In the list the northern and southern limits are indicated in parentheses.

- Allium vineale* (Connecticut to Georgia).
Amaranthus pumilus (Rhode Island to South Carolina).
Celtis occidentalis (Quebec to North Carolina).
Chenopodium Botrys (Nova Scotia to Georgia).
Digitaria filiformis (Massachusetts to North Carolina).
Festuca rubra (Labrador to Virginia).
Panicum dichotomum (Connecticut to Georgia).
Panicum spretum (New York to Georgia).
Polypogon monspeliensis (New Hampshire to South Carolina).
Vitis labrusca (New England to Georgia).

¹See Kearney, l. c., p. 314.

COMPARISON OF BEAUFORT FLORA WITH THAT OF OTHER LITTORAL REGIONS

	Species	Genera
I. Ocracoke Island (Kearney, l. c.)—		
Total number.....	135	111
Also found at Beaufort.....	107	99
Per cent common to both localities.....	79.2	89.2
II. Isle of Palms, S. C.¹		
Total number.....	115	96
Also found at Beaufort.....	81	88
Per cent common to both localities.....	70.4	91.6
Per cent common to Ocracoke and Isle of Palms.....	40.8	
III. Alabama²—		
Total number.....	107	83
Also found at Beaufort.....	41	56
Per cent common to both localities.....	38.3	67.4
IV. Florida Keys³—		
Total number.....	84 ⁴	76
Also found at Beaufort.....	9	25
Per cent common to both localities.....	10.7	32.9

Of the species listed by Mohr for Alabama, only those are counted here which are stated to occur in the littoral belt. The great majority of Beaufort species occur in the coastal plain region of Alabama, while only 41 per cent are characteristic of the littoral belt. The table serves to show how closely the floras of littoral North and South Carolina approximate, and also how much more nearly similar the floras of Alabama and Beaufort are than those of the Florida Keys and Beaufort. Of the regions compared, the Florida Keys are alone outside the Austro-riparian area.

¹Coker, W. C., Observations on the Flora of the Isle of Palms, Charleston, S. C.; *Torreya*, V, 135-145, 1905.

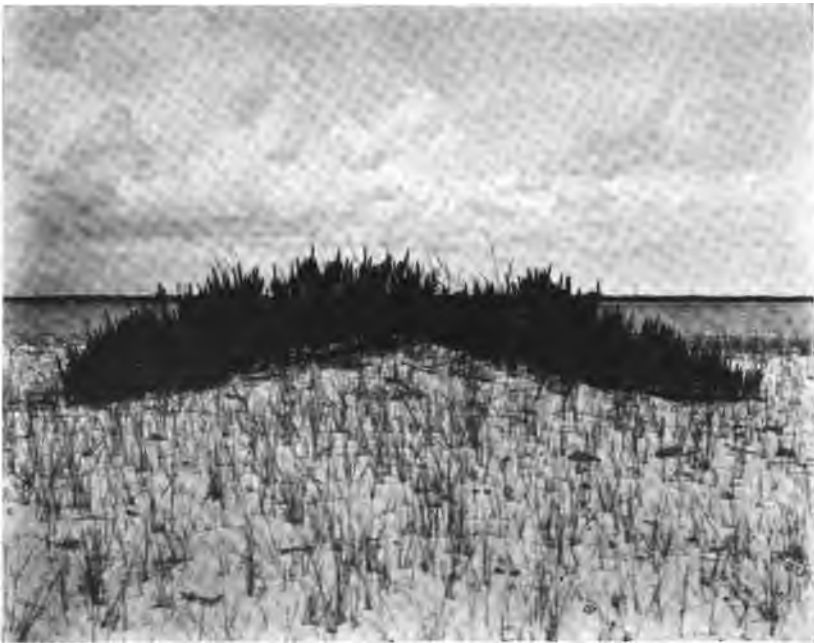
²Mohr, C., Plant Life of Alabama; Contributions from the U. S. National Herbarium, VI, 921, pp., 1901.

³Millsbaugh, C. F., Flora of the Sand Keys of Florida; Publications of the Field Columbian Museum, II, 191-245, 1907.

⁴Of these, 62 are confined to Florida and the tropics.



A. Isolated grove of live-oak (*Quercus virginiana*) on mainland; similar to those on Shackleford. (Photo by W. D. Hoyt)



B. Small dune formed by *Iva oraria*; in the foreground is *Spartina patens*

LIST OF SPECIES¹

POLYPODIACEÆ

- † *Aspidium Thelypteris* (L.) Sw.;
Dryopteris Thelypteris (L.) A. Gray.
 e *Asplenium platyneuron* (L.) Oakes.
 f† *Onoclea sensibilis* L.
 f *Polypodium polypodioides* (L.) Hitch.
 f *Pteris aquilina* L.

OSMUNDACEÆ

- f *Osmunda regalis* L.

PINACEÆ

- e *Juniperus virginiana* L.
 f *Pinus taeda* L.

TYPHACEÆ

- h *Typha augustifolia* L.

SPARGANIACEÆ

- †* *Sparganium americanum* Nutt. var. *androcladum* (Engelm.) Fern. & Eames.; (*S. androcladum* (Eng.) Morong).

NAJADACEÆ

- Zostera marina* L.

JUNCAGINACEÆ

- h *Triglochin striata* R. & P.

ALISMACEÆ

- * *Sagittaria lancifolia* L.
 † *Sagittaria latifolia* Willd.

GRAMINEÆ

- †† *Andropogon tetrastachyus* Ell.
 a, b *Cenchrus tribuloides* L.
Cynodon Dactylon (L.) pers.; (*Ca-*
priola Dactylon (L.) Ktze).

Digitaria filiformis (L.) Koeler;
 (*Syntherisma filiformis* (L.) Nash).

Digitaria sanguinalis (L.) Scop.;
 (*Syntherisma filiformis* (L.) Nash).

h *Distichlis spicata* (L.) Greene.

† *Echinochloa Walteri* (Pursh.) Nash;
 (*Panicum Walteri* Pursh).

Eleusine indica (L.) Gaert.

Elymus virginicus L.

Eragrostis pectinacea (Michx.) Steud.

α *Eustachys petraea* (Sw.) Desv.;
 (*Chloris petraea* Sw.).

†* *Festuca rubra* L.

Panicum Sp.

† *Panicum amarum* Ell.

Panicum anceps Michx.

e *Panicum commutatum* Schultes.

e *Panicum dichotomum* L. (?)

Panicum lancerearium Trin. (?);
 (*P. Nashianum* Scribn. (?)).

e *Panicum lanuginosum* Ell.; (*P. pubescens* Lam.).

e *Panicum sphaerocarpon* Ell.

e *Panicum spretum* Schultes(?); (*P. nitidum* Lam. (?)).

† *Panicum virgatum* L.

Paspalum ciliatifolium Michx.

j *Paspalum distichum* L.

† *Paspalum floridanum* Michx.

Paspalum laeve Michx. var. *australe* Nash.

Phleum pratense L.

Polypogon monspeliensis (L.) Desf.

† *Sacciolepis striata* (L.) Nash; (*Panicum gibbum* Ell.).

h *Setaria imberbis* R. & S. var. *perennis* (Hall) Hitch.; (*Chaetochloa versicolor* Bickn.).

g *Spartina glabra* Muhl.; (*S. stricta* (Ait.) Roth.).

a, b *Spartina patens* (Ait.) Muhl. var. *junccea* (Michx.) Hitch.

¹No collections were made later than August, and it is therefore probable that some of the late-blooming species are not included. This applies especially to the Compositæ.

Sporobolus indicus (L.) R. Br.

e Stipa avenacea L.

e Triplasis purpurea (Walt.) Chapm.;
(*Sieglingia purpurea* (Walt.)
Ktze.).

e Uniola laxa (L.) B. S. P.

b Uniola paniculata L.

Muhlenbergia capillaris Curtis.

CYPERACEÆ

† Cladium jamaicense Crantz; (C.
effusum (Sw.) Torr.).

† Cyperus cylindricus (Ell.) Britton.

† Cyperus ferax Rich.; (C. *speciosus*
Vahl.).

† Cyperus flavescens L.

† Cyperus haspan L.

† Cyperus microdontus Torr.

h Cyperus Nuttallii Eddy.

† Cyperus retrofractus* (L.) Torr.

† Cyperus strigosus L.

† Dichromena colorata (L.) Hitch.

† Dichromena latifolia* Baldw.

† Dulichium arundinaceum (L.) Britt-
ton.

h Eleocharis albida Torr.

† Eleocharis microcarpa Torr.

h Eleocharis ochreate (Nees) Steud.

h Eleocharis Robinsii Oakes. (?)

Fimbristylis autumnalis (L.) R. & S.

h Fimbristylis castanea (Michx.)
Vahl.

h Fimbristylis spadicea (L.) Vahl.

† Fuirena hispida Ell.

† Rynchospora glomerata (L.) Vahl.

†† Rynchospora stipitata Chapm.

h Scirpus americanus Pers.

h Scirpus validus Vahl.; (S. *lacustris*
Am. auth.).

† Scleria triglomerata Michx.

† Stenophyllus stenophyllus (Ell.)
Britton.

PALMÆ

†† Sabal glabra (Mill.) Sarg.; (S. *Ad-
ansonii* Guerns.).

ARACEÆ

† Acorus Calamus L.

XYRIDACEÆ

d Xyris arenicola* Small; (X. *torta*
J. E. Smith).

COMMELINACEÆ

Commelina sp.

d Commelina angustifolia Michx.

JUNCACEÆ

Juncus marginatus Rostk.

h Juncus megacephalus Curtis.

h Juncus Roëmerianus Scheele.

† Juncus setaceus Rostk.

† Juncus tenuis Willd.

LILLIACEÆ

** Allium vineale* L.

e Smilax Bona-nox L.

e Smilax glauca Walt.

e Smilax laurifolia L.

d Yucca aloifolia L.

ORCHIDACEÆ

Spiranthes ovalis Lindl.(?); (*Gyro-
stachys parviflora* (Chapm.)
Small(?)).

PIPERACEÆ

†† Saururus cernuus L.

SALICACEÆ

† Salix sp.

MYRICACEÆ

d Myrica carolinensis Mill.

e Myrica cerifera L.

JUGLANDACEÆ

† Carya glabra* (Mill.) Spach.; (*Hico-
ria glabra* (Mill.) Britton).

BETULACEÆ

† Carpinus caroliniana Walt.



Ilex vomitoria as a wind-break in exposed localities

44

FAGACEÆ

- f** *Quercus falcata* Michx.; (*Q. digitata* Sudw.).
f *Quercus nigra* L.; (*Q. aquatica* Walt.).
f *Quercus phellos* L. var. *laurifolia* (Michx.) Chapm.
*f** *Quercus stellata* Wang.; (*Q. minor* (Marsh) Sarg.).
e, f *Quercus virginiana* Mill.

URTICACEÆ

- i* *Boehmeria cylindrica* (L.) Sw.
Celtis occidentalis L.
f *Morus rubra* L.
i *Parietaria floridana* Nutt.
i *Pilea pumila* (L.) Gray; (*Adicea pumila* (L.) Raf.).

LORANTHACEÆ

- f* *Phoradendron flavescens* (Pursh.) Nutt.

POLYGONACEÆ

- i* *Polygonum acre* H. B. K. var. *leptostachyum* Meisn.; (*P. punctatum* Ell. var. *leptostachyum* (Meisn.) Small).
Polygonum lapathifolium L.
a *Polygonum maritimum* L.
i *Polygonum setaceum* Baldw.
 * *Rumex hastatulus*

CHENOPODIACEÆ

- a* *Atriplex arenaria* Nutt.
Atriplex patula L. (?)
a *Chenopodium anthelminticum* L.
a *Chenopodium Botrys* L.
a *Chenopodium glaucum* L.
a *Chenopodium viride* L.
g *Salicornia ambigua* Michx.
g *Salicornia mucronata* Bigel.; (*S. Bigelowii* Torr.).
a, b *Salsola Kali* L.
h *Suaeda linearis* (Ell.) Moq.; (*Dondia linearis* (Ell.) Millsp.).

AMARANTHACEÆ

- e* *Acnida cannabina* L.
b *Amaranthus pumilus* Raf.

PHYTOLACCACEÆ

- Phytolacca decandra* L.

AIZOACEÆ

- a* *Sesuvium maritimum* (Walt.) B. S. P.

CARYOPHYLLACEÆ

- f* *Arenaria lanuginosa* (Michx.) Rohrb.
e† *Anychlastrum Baldwinii* (T. & G.) Small.

PORTULACACEÆ

- a* *Portulaca oleracea* L.

MAGNOLIACEÆ

- f* *Magnolia virginiana* L.

LAURACEÆ

- e, f* *Persea borbonia* (L.) Spreng.
e, f *Persea pubescens* (Pursh) Sarg.
f *Sassafras variifolium* (Salisb.) Ktze.; (*S. officinale* Nees. and Eberm.).

CRUCIFERÆ

- f* *Lepidium virginicum* L.

ROSACEÆ

- Laurocerasus caroliniana* (Mill.) Roem.
Rosa carolina L.
d *Rubus trivialis* Michx.
† *Rubus persistens* Rydb. (?)

LEGUMINOSÆ

- f* *Aplos tuberosa* Moench.
d *Cassia chamaecrista* L.
e *Desmodium paniculatum* (L.) DC.; (*Melbomia paniculata* (L.) Ktze.).

- e* Galactia volubilis (L.) Britton.
e Strophostyles umbellata (Muhl.) Britton.
 Trifolium repens L.

LINACEÆ

- f* Linum medium (Planch.) Britton.

RUTACEÆ

- e* Zanthoxylum Clava-Herculis L.

SIMARUBACEÆ

- f* Allanthus glandulosa Desf.

MELIACEÆ

- Melia Azedarach L.

POLYGALACEÆ

- †* Polygala verticillata L.

EUPHORBIACEÆ

- e* Acalypha gracilens Gray.
d Croton glandulosus L. var. septentrionalis Muell. Arg.
a, b Croton punctatus Jacq.
f Euphorbia sp.
a Euphorbia maculata L.
b Euphorbia polygonifolia L.
f Jatropha stimulosa Michx.
 Ricinus communis L.

ANACARDIACEÆ

- Rhus copallina L.
e, f Rhus toxicodendron L. var. radicans Torr.

AQUIFOLIACEÆ

- e* Ilex glabra (L.) Gray.
f Ilex opaca Ait.
d, e, f Ilex vomitoria Ait.

RHAMNACEÆ

- e, f* Berchemia scandens (Hill) Trel.

VITACEÆ

- e* Cissus arborea (L.) Des. Moul.; (Ampelopsis arborea (L.) Rusby).

- e* Psedera quinquefolia (L.) Greene; (Parthenocissus quinquefolia (L.) Planch.).

- e* Vitis aestivalis Michx.
e Vitis labrusca L.
e Vitis rotundifolia Michx.

TILIACEÆ

- f* Tilia Michauxii Nutt.; Tilia pubescens Ait.).

MALVACEÆ

- †* Kosteletzkya virginica (L.) Presl.

TAMARICACEÆ

- Tamarix gallica L.

HYPERICACEÆ

- e* Ascyrum hypericoides L.
e Hypericum mutilum L.
† Hypericum virginicum L.; (Triadenum virginicum (L.) Raf.).

CISTACEÆ

- e, f* Lechea villosa Ell.

PASSIFLORACEÆ

- e* Passiflora incarnata L.
e Passiflora lutea L.

CACTACEÆ

- d* Opuntia vulgaris Mill.; (Opuntia opuntia (L.) Coult.).

LYTHRACEÆ

- †* Amannia Koehnei Britton.
*†** Decodon verticillatus (L.) Ell.
† Lythrum lineare L.

ONAGRACEÆ

- d* Gaura angustifolia Michx.
d Kneiffia arenicola Small.
† Ludvigia alata Ell.
† Ludvigia microcarpa Michx.
† Ludvigia palustris (L.) Ell.; (Isnardia palustris L.).

† *Ludvigia virgata* Michx.
c *Oenothera humifusa* Nutt.

HALORAGIDACEÆ

†* *Myriophyllum verticillatum* L.
† *Proserpinaca pectinata* Lam.

ARALIACEÆ

f *Aralia spinosa* L.

UMBELLIFERÆ

h *Centella asiatica* (L.) Urban.; (C. repanda (Pers.) Small).
f *Cicuta Curtissii* Coult. & Rose.
h *Hydrocotyle umbellata* L.
† *Hydrocotyle verticillata* Thunb.
h *Lilaeopsis lineata* (Michx.) Greene.
h *Ptilimnium capillaceum* (Michx.) Raf.
c *Sanicula canadensis* L.

CORNACEÆ

f *Cornus florida* L.

ERICACEÆ

f* *Lyonia nitida* (Bartr.) Fernald;
(*Pieris nitida* (Bartr.) B. & H.).
f* *Vaccinium arboreum* Marsh.

PLUMBAGINACEÆ

h *Limonium carolinianum* (Walt.) Britton.

PRIMULACEÆ

h *Samolus floribundus* HBK.

EBENACEÆ

f *Diospyros virginiana* L.

OLEACEÆ

f *Osmanthus americana* (L.) B. & H.

LOGANIACEÆ

† *Cynoctonum mitreola* (L.) Britton.
c *Gelsemium sempervirens* (L.) Ait. f.

GENTIANACEÆ

h *Sabatia stellaris* Pursh.

APOCYNACEÆ

c *Apocynum cannabinum* L.

ASCLEPIADACEÆ

† *Asclepias lanceolata* Walt.
h *Seutera palustris* (Pursh.) Vail;
(*Vincetoxicum palustre* (Pursh.) Gray).
c *Vincetoxicum suberosum* (L.) Britton.

CONVOLVULACEÆ

† *Cuscuta arvensis* Beyrich.
† *Ipomoea sagittata* Cav.

BORAGINACEÆ

c *Heliotropium curassavicum* Cav.

VERBENACEÆ

c *Callicarpa americana* L.
† *Lippia nodiflora* (L.) Michx.
†† *Verbena polystachya* HBK.

LABIATÆ

Marrubium vulgare L.
c, f *Monarda punctata* L.
* *Teucrium canadense* L. var. *littorale*
(Bicknell) Fernald.
† *Trichostema dichotomum* L.

SOLLANACEÆ

Datura Stramonium L.
c *Physalis pubescens* L.
c *Physalis viscosa* L.
c *Solanum carolinense* L.
c *Solanum gracile* Link.

SCROPHULARIACEÆ

h *Bacopa Monniera* (L.) Wettst.;
(*Monniera Monniera* (L.) Britton).
h *Gerardia maritima* Raf.
Verbascum Thapsus L.

LENTIBULARIACEÆ

- * *Utricularia purpurea* Walt.

PLANTAGINACEÆ

- * *Plantago lanceolata* L.

RUBIACEÆ

- ‡ *Diodia virginiana* L.
 ‡ *Diodia teres* Walt.
 e *Gallium hispidulum* Michx.
 e *Gallium pilosum* Ait. var. *puncticulosum* (Michx.) (T. & G.).
 e *Mitchella repens* L.

CAPRIFOLIACEÆ

- e *Lonicera sempervirens* L.

CUCURBITACEÆ

- a *Lagenaria vulgaris* Ser.; (*Lagenaria Lagenaria* (L.) Cock.).
 d, e *Melothria pendula* L.

AMBROSIIACEÆ

- f *Ambrosia artemisiæfolia* L.
 a *Iva oraria* Bartl.; (*I. frutescens* L.).
 a *Iva imbricata* Walt.
 a *Xanthium* sp.

CICHORIACEÆ

- e *Hieracium Gronovii* L.
 f *Lactuca canadensis* L.
 * *Sonchus asper* (L.) Hill.

CARDUACEÆ

- a *Baccharis halimifolia* L.
Bidens bipinnata L.
 g *Borreria frutescens* (L.) DC.
 * *Carduus* sp.
 e *Cirsium spinosissimum* (Walt.) Scop.; (*Carduus spinosissimus* Walt.).
 ‡ *Eclipta alba* (L.) Hassk.
 e, f *Elephantopus nudatus* Gray.
 e *Erechthites hieracifolia* (L.) Raf.
 e *Erigeron canadensis* L.; (*Leptilon canadensis* (L.) Britton).
Eupatorium capillifolium (Lam.) Small.
Heterotheca subaxillaris (Lam.) Britton and Rusby.
 e, i *Mikania scandens* (L.) Willd.; (*Willughbaea scandens* (L.) Ktze.).
 ‡ *Pluchea camphorata* (L.) DC.
 ‡ *Pluchea foetida* (L.) B. S. P.
Senecio vulgaris L.
 f *Solidago odora* Ait.
 e *Solidago sempervirens* L.

*Not collected on Shackleford, but on some of the neighboring islands.

†Range here extended.

‡Listed by Johnson (*), not observed by the writer.

aCharacteristic of the inner beach formation.

bOuter beach formation.

cDune formation.

dThicket formation.

eThicket woodland formation.

fWoodland formation.

gSalt marsh formation.

hCreek Marsh formation.

iDune marsh formation.

jTidal flat formation.

*Johnson, D. S., Notes on the Flora of the Banks and Sounds at Beaufort, N. C.: Bot. Gazette, 30, 405-409, 1900.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
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7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
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9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
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25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, 176 pp., 20 pl., 16 figs., 1 map. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, 124 pp. *Postage 20 cents.*

ECONOMIC PAPERS

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3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuretted Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

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Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

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Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

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24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

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30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

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35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Out of print.*

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39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

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42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

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46. The Vegetation of Shackleford Bank, by I. W. Lewis, 1917. 8°, 40 pp., 11 plates. *Postage 10 cents.*

47. Proceedings of the Ninth Annual Drainage Convention. Held under the auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Greensboro, N. C., November 22 and 23, 1916. ... pp., ... figs. *Postage ... cents.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy \$1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 —pl., 188 figs. *Postage 35 cents. Price \$1.50.*

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Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in

Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. *Postage 20 cents.*

Administrative Report.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

MORRIS HYDE PRATT, Chief Geologist

ECONOMIC PAPER No. 11

PROCEEDINGS

NINTH ANNUAL DRAINAGE CONVENTION

NORTH CAROLINA DRAINAGE ASSOCIATION

Held at

GREENSBORO, NORTH CAROLINA

NOVEMBER 21 AND 22, 1916

EDITED BY

JOSEPH HYDE PRATT, Chief Geologist

AND H. M. BERRY, Secretary



PRINTED BY THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY
GREENSBORO, N. C.
1917

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 47

PROCEEDINGS
OF THE
NINTH ANNUAL DRAINAGE CONVENTION

OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION

HELD AT
GREENSBORO, NORTH CAROLINA
NOVEMBER 22 AND 23, 1916

COMPILED BY
JOSEPH HYDE PRATT, State Geologist
AND
MISS H. M. BERRY, Secretary



RALEIGH
EDWARDS & BROUGHTON PRINTING CO.
STATE PRINTERS
1917

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., June 1, 1917.

*To His Excellency, HON. T. W. BICKETT,
Governor of North Carolina.*

SIR:—On November 22d and 23d, 1916, there was held at Greensboro, North Carolina, the Ninth Annual Convention of the North Carolina Drainage Association. Because of the importance of the drainage of our swamp and overflowed lands to the development of North Carolina, the value of this work, as shown in the papers and discussions at the Convention, is such that we recommend the publication of these Proceedings by the Survey. They are herewith submitted as Economic Paper No. 47, of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,
JOSEPH HYDE PRATT,
State Geologist.

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INTRODUCTION

Since its organization, the North Carolina Drainage Association has worked in close coöperation with the North Carolina Geological and Economic Survey; and, in arranging for the Ninth Annual Convention, which was held at Greensboro, November 22 and 23, 1916, the work was done by these two agencies. It is largely through these conventions and the articles sent to the press by the Association and the Survey that public opinion has been awakened to the great importance to the State of the drainage of the wet lands, including both the swamp lands of the Coastal Plain and the overflowed lands of the Piedmont and mountain regions.

At the Eighth Annual Convention it was decided to emphasize the subject of Tile Drainage, and, with this in view, the following letter regarding tile drainage contests among the boys of the agricultural clubs and among North Carolina farmers was prepared and sent to the press, together with rules and regulations governing these contests:

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., September 29, 1916.

To the Editors of the North Carolina Press.

DEAR SIR:—Enclosed I am sending you two notices in regard to Tile Drainage Contest for boys of the Agricultural Clubs and for farmers of the State. These contests are to be conducted under the auspices of the North Carolina Drainage Association at its annual convention, which is to be held at Greensboro, North Carolina, November 22 and 23.

The use of tile drainage in this State will undoubtedly add an almost unbelievable amount to the agricultural values of many of our lands, and the spread of this propaganda will mean much to the advancement of the agricultural interests of the State. I am, therefore, requesting the newspapers to print these notices in full at a very early date so that as many of our farmers and members of the Boys' Agricultural Clubs as possible can learn of the contest and make plans for entering it. By doing this we feel that you will render a real service to your county and to the State generally.

We appreciate the coöperation which the press of the State has given in advancing the cause of drainage, and bespeak your further coöperation in taking a step further to disseminate this information about tile drainage, which is now considered so essential to securing the best results from many of our farm lands.

With best wishes, I am

Cordially yours,

JOSEPH HYDE PRATT,
Secretary.

NORTH CAROLINA DRAINAGE ASSOCIATION

Press Notice.

CHAPEL HILL, N. C., September 29, 1916.

TILE DRAINAGE CONTEST FOR BOYS' AGRICULTURAL CLUBS

ANNOUNCEMENT AND RULES GOVERNING CONTEST

The North Carolina Drainage Association wishes to encourage the young men of the State in underdrainage of their wet lands in order that they may receive maximum yields with minimum effort; and that the educational value of the club work may be enhanced. To this end the Association offers a gold medal to the member of the Boys' Agricultural Clubs who submits the most approved plan for the underdrainage of a field or portion of a field.

The following rules apply:

1. The field may be of any size from one acre up and may be selected by the contestant from any land in which he is interested.

2. The plans shall consist of:

(a) A description of the field, including location, acreage, shape, topography, description of the soil and subsoil, present use of the land and present conditions as regards natural drainage.

(b) A drawing or sketch showing the shape of the field, location and arrangement of proposed drains, location of the canal, creek, or open ditch into which the proposed drains are to discharge, and any other points mentioned in the description.

(c) Number of feet of tile required for each line, with size and cost of tile, and estimated cost of digging and backfilling the ditches.

(d) Estimated cost per acre.

3. The plans must represent or express the contestant's own ideas in adapting a system of drainage to the field selected, though he may consult others in making his plans and will be furnished needed information upon application to the Vice-President in Charge of Tile Drainage (Prof. M. E. Sherwin, West Raleigh, N. C.).

4. The plans shall be mailed to the Secretary of the North Carolina Drainage Association (Dr. Joseph Hyde Pratt, Chapel Hill, N. C.), so that it shall be in his hands before the time of the Annual Convention of the Association which is to be held in Greensboro, N. C., November 22 and 23, 1916; or shall be filed with the Secretary on the first day of the Convention.

5. The contestant shall not be obligated to construct the drains as planned, though their construction would probably be profitable.

6. The plans shall be judged by a committee appointed by the President of the Association, and the award shall be made in open session of the Convention.

NORTH CAROLINA DRAINAGE ASSOCIATION

Press Notice.

CHAPEL HILL, N. C., September 29, 1916.

A TILE DRAINAGE CONTEST FOR NORTH CAROLINA FARMERS

ANNOUNCEMENT AND RULES GOVERNING CONTEST

To stimulate interest among the farmers of the State and to aid in the dissemination of information regarding the benefits of tile drainage, the North

Carolina Drainage Association offers a prize of \$10 to the farmer who submits the best report of benefits actually received from tile drains.

The following rules apply:

1. The area reported upon may be of any size, shape, and location within the State.

2. The report shall include:

(a) A description of the field, including location, acreage, shape, topography, and description of the soil and subsoil.

(b) A statement of the drainage conditions before the tile drains were constructed and the crops grown (if any), with approximate or accurate yields received.

(c) A statement of the present drainage conditions and crops grown, with approximate or accurate yields received.

(d) A drawing or sketch showing the shape of the field, location and arrangement of tile drains, location of canal, creek, or open ditch into which the drains discharge, and height of water in the same, and any other points mentioned in the description.

(e) Number of feet and size of tile used, cost of tile, and cost of digging and backfilling the ditches.

(f) Total cost per acre.

3. The report shall be mailed to the Secretary of the North Carolina Drainage Association (Dr. Joseph Hyde Pratt, Chapel Hill, N. C.), so that it shall be in his hands before the time of the Annual Convention of the Association which is to be held in Greensboro, N. C., November 22 and 23, 1916; or shall be filed with the Secretary on the first day of the Convention.

4. The report shall be judged by a committee appointed by the President of the Association, and the award shall be made in open session of the Convention.

The following letter was sent to the farmers of North Carolina, through the Bureau of Extension of the Department of Agriculture at Raleigh, together with the rules governing this contest.

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., September 29, 1916.

MY DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association will be held at Greensboro, N. C., November 22 and 23, and I sincerely hope that you are going to be able to attend. One of the subjects to be emphasized at this Convention is Tile Drainage, and we are arranging for Tile Drainage Contests among the boys of the Agricultural Clubs and also among the farmers of the State. I am inclosing herewith copy of the rules and regulations governing the contest for farmers, and sincerely hope that you will become interested and will take part in it. We believe this to be a most important phase of drainage work and worthy of very serious consideration on the part of our farmers, if they hope to obtain the greatest value from a considerable portion of their lands.

Arrangements for the program have not yet been completed; but as soon as they are I will write you more fully regarding the Convention. I am send-

ing this preliminary notice so that you will have an opportunity to take part in the contest and to get ready for the Convention. Delegates are invited to make exhibits consisting of pictures of their lands before and after drainage, and of growing crops, maps, charts, and samples of crops from drained lands. If you know of any other persons in your neighborhood who would like to attend the Convention or take part in this contest, I will appreciate your sending me their names and addresses.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,

Secretary.

In arranging for the Convention, the following letter was sent to the chairman of the boards of county commissioners, asking them to appoint delegates to represent their respective counties; to the mayors of cities and towns for the appointment of delegates to represent their municipalities; to the presidents of boards of trade and chambers of commerce for the appointment of delegates to represent their bodies; and to the commissioners of drainage districts already established, for the appointment of delegates to represent their individual districts:

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., October 20, 1916.

MY DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association is to be held at Greensboro, North Carolina, November 22 and 23. The drainage of the swamp and overflowed areas of the State has become a tremendously important factor in the reclamation of these waste lands; in rendering them more healthful and hence more habitable; and in adding enormously to their economic value. The North Carolina Drainage Association has been the principal factor in developing public sentiment so as to make possible the passage of the North Carolina Drainage Law, and at its annual conventions there have been free discussions of topics relating to drainage which have been of great value to those connected with the drainage work. As a result of this drainage work there have been reclaimed in the swamp areas approximately 800,000 acres in 59 districts. The reclamation of these lands means that land which was formerly bringing in no revenue to the owner is now producing from 20 to 100 bushels of corn to the acre, from 1 to 2 bales of cotton, and other crops in like proportion. In the Piedmont section of the State the overflowed lands along the creeks and rivers are being reclaimed, and 60 of these districts have been organized.

In addition to the reclamation of these waste lands, the North Carolina Drainage Association is interested in increasing the yield of all farm lands in so far as this may be done by drainage; and, for this reason, is seeking to interest our farmers in tile drainage, terracing, etc. To this end the Association is offering to the farmers of the State a prize of \$10 for the best report on results obtained from tile drainage; and to the boys of the Agricultural Clubs a gold medal for the best plan for a tile-drained field.

I am writing to extend to you a most cordial invitation to attend the Convention at Greensboro as a delegate, and to ask that you appoint *ten other*

delegates to represent your county at the Convention. We want to have full discussions of the North Carolina Drainage Law and such amendments as may seem to be needed to make it more effective. All delegates are earnestly invited and urged to bring up any suggestions they may have in regard to amendments to the law. It is believed that a full discussion of all the difficulties met with in connection with our drainage operations—whether due to the inelasticity of the law or to difficulties met with in the sale of bonds, or whatever the problem may be—will yield a resulting benefit to our drainage work.

I sincerely hope that you will make a special effort to attend the Convention and will urge those whom you appoint as delegates to attend. Please send me the names and addresses of those whom you appoint.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,
Secretary.

The following letters of notification and information in regard to program, arrangements for delegates, exhibits, etc., were mailed to all delegates appointed, and also to the members of the North Carolina Drainage Association:

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., November 1, 1916.

DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association is to be held at Greensboro, November 22 and 23, and I sincerely hope that you can arrange to attend. We are inviting those directly interested in drainage districts to bring pictures to the Convention illustrating their drainage work and results obtained from the lands after drainage. I believe samples of products from these lands would likewise be of interest.

I also hope you can prepare a brief written report to submit to the Convention as to what has been accomplished in your district. If you cannot be present at the Convention, I hope you can send such written report to me ahead of time to submit to the Convention. We will send you further information in regard to program for the Convention later.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,
Secretary.

NORTH CAROLINA DRAINAGE ASSOCIATION

CHAPEL HILL, N. C., November 10, 1916.

MY DEAR SIR:—The Ninth Annual Convention of the North Carolina Drainage Association is to be held at Greensboro, N. C., November 22 and 23, and you have been appointed a delegate to this Convention. I sincerely hope that you can make your arrangements to attend, as I believe it will be the most important Convention we have yet held. The drainage work of the State is becoming each year of more value to our people, and we feel that at these annual meetings many subjects are discussed which are of vital importance

to those who are engaged in this drainage work. At this meeting the principal subjects to be discussed are:

Tile Drainage, under which head will be included other forms of farm drainage, such as terracing, etc.; the North Carolina Drainage Law, with a view to amendments which should be made by the Legislature of 1917; reports of representatives from Drainage Districts; Maintenance of Drainage Ditches; Drainage Bonds; the Financing of Drainage Projects with reference to the Federal Farm Loan Banks, etc.

In connection with the Tile Drainage Session, there will be reports from farmers who have installed tile drainage successfully, there will be a trip to the plant of the Pomona Terra Cotta Company, where tile drain is made; and it is expected that there will be a demonstration of a six-horse ditching machine and a traction ditcher; and other features which will be of interest to those who are connected with drainage work.

We want to make this the best Convention that we have ever held, and in order for it to be a success we must have a large and interested attendance.

Headquarters of the Convention will be the Guilford Hotel. Other hotels are the Clegg, Huffine, Carolina, and Blandwood. These are all European plan. Reservations for rooms should be made ahead of time. The meetings will be held in the Elks' Club, which is diagonally across the street from the Guilford Hotel.

I sincerely hope that you can plan to be present for the two full days, and if you know of others in your neighborhood who would like to attend, we would be glad to appoint them as delegates also, if you will send in their names and addresses.

With best wishes, I am

Yours sincerely,

JOSEPH HYDE PRATT,
Secretary.

There was also sent to the press and to delegates appointed the following notice in regard to the Convention:

CHAPEL HILL, N. C., November 8, 1916.

NORTH CAROLINA DRAINAGE CONVENTION
GREENSBORO, N. C.

NOVEMBER 22 AND 23, 1916.

The Ninth Annual Convention of the North Carolina Drainage Association will be held at Greensboro, November 22 and 23, with headquarters at the Guilford Hotel. The meetings will be held in the Elks' Club. All citizens who are interested in the reclamation of the swamp lands of the coast or overflowed areas in central and western North Carolina are most cordially invited to attend the sessions of the Convention.

The object of the reclamation of these lands is threefold: (1) to increase the healthfulness in the section of the country in which the swamp or overflowed areas exist; (2) to make a nonproducing area productive, and thus add to the revenue of the Commonwealth; (3) to facilitate intercourse between communities adjacent to these swamp areas by the construction of roads, which always follows the drainage of any swamp area.

Up to the present time, about 122 drainage districts have been organized to reclaim between 800,000 and 1,000,000 acres of land which, before drainage, was not only unproductive, but a menace to the health of the community. Before drainage these lands were listed at from 25 cents to \$1 per acre. After being drained and cleared the land is worth from \$50 to \$150 and more per acre. The cost of drainage varies from \$4 to \$6 per acre in the swamp district to \$15 to \$25 per acre in the Piedmont.

Problems connected with the drainage of these areas will be discussed at the Convention, as well as further amendments to the drainage law. The Association, however, has undertaken further educational work in connection with drainage, which relates especially to farm drainage, such as tile drainage, terracing, etc. Prizes are being offered by the Association at this Convention to the farmer who will submit the best report of benefits actually received through tile drainage, and to a member of the Boys' Agricultural Clubs for the most approved plan for the underdrainage of a field or a portion of a field. Rules governing these contests have been mailed to farmers who have undertaken tile drainage and to members of the Boys' Agricultural Clubs. It is expected that this will be the means of awakening a widespread interest in this form of drainage, which means so much in increasing the productivity of a great deal of the farm lands of the State.

The delegates to the Convention will have the privilege of inspecting the plant of the Pomona Terra Cotta Company, where tile drain is being manufactured, and it is expected that we will be able to have a demonstration of a six-horse power ditching machine, and a traction ditcher.

There will be discussions from representatives of bond houses in regard to such changes as they may think should be made in the drainage law to make the drainage bonds more salable. There will also be discussions in regard to the financing of drainage districts with reference to the farm loan banks.

As stated above, every citizen in the State who is interested in this vast project of conservation and reclamation is cordially invited to attend the sessions of the Convention and take part in the proceedings.

JOSEPH HYDE PRATT.

Secretary, N. C. Drainage Association.

PROCEEDINGS
OF THE
NINTH ANNUAL CONVENTION
OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION

GREENSBORO, N. C., NOVEMBER 22-23, 1916

WEDNESDAY, NOVEMBER 22, 1916—Morning Session

The Convention was called to order by the President, Mr. P. H. Johnson, at 10 a. m. in the Courthouse. The Convention was opened with prayer by the Rev. C. F. Murray of Greensboro, as follows:

"O Lord, Thou art a spirit, infinite, eternal, unchangeable. We stand in Thy presence this morning and recognize Thee as the author and finisher of every good work. We come as co-laborers with Thee in this, a part of our work. We ask Thee to bless this Convention. May we be linked up with the Lord Almighty; wilt Thou continue to smile in approval upon us. May we measure up to the fullness of our gifts. We ask it in Christ's name. Amen."

ADDRESS OF WELCOME ON BEHALF OF THE CITY OF GREENSBORO

HON. N. L. EURE:

Mr. Chairman and Gentlemen: The Mayor, in his absence, has asked me to come up here this morning and to extend a hearty welcome to you gentlemen to our city, and I want to say to you that we are always delighted to have good citizens come among us, and especially are we very much delighted this morning to have you gentlemen come here and assemble in our midst for this great purpose which you have come; that is, to look after the general drainage work of the State of North Carolina. There are a good many things I might say. I know very little of the drainage question of North Carolina, but I do know that you gentlemen are here in the interest of the welfare of the State, and to give it greater wealth, and broader acres for cultivation, and we are especially delighted to have you come here among us for such a great purpose, and we trust that your stay here will be exceedingly pleasant and that you may get more out of this meeting than any held heretofore; that your deliberations may mean much for the State of North Carolina now and in the future. It gives me very much pleasure indeed to extend a hearty welcome to you, and we trust that you will have a very good time while you are here. I give you this welcome in the name of the City of Greensboro.

ADDRESS OF WELCOME FROM THE CHAMBER OF COMMERCE
OF GREENSBORO

HON. C. L. BROOKS, President:

Mr. Chairman, Lady and Gentlemen: On behalf of the Chamber of Commerce of Greensboro and the business interests of this city, I desire to extend to you a most cordial welcome to our city. It has been counted as the greatest achievement of statesmanship in the past when a man or set of men could make two blades of grass grow where only one grew before; but I am convinced that it is a very much greater thing for a man or set of men to make many blades of grass grow where none grew before—such as you gentlemen are doing. You are engaged, in my opinion, in perhaps the most interesting, far-reaching, and constructive character of work that any set of men engaged in secular business in North Carolina are now at work on. You are not only reclaiming a great deal of waste land, but you are at the same time rendering the State a distinct service along its health lines. There is nothing more beautiful in nature than the creation of something new; that is why man, since he first became civilized, has tipped his hat to the mother who gives to the world a strong child; and the men in a State such as North Carolina, where most of those in the past have thought all was done that could be done, are glad to see that they are a set of forward-looking, progressive citizens who have conceived this great work of reclaiming for the State, as if from the grave, what I understand by some is considered as worth fifty millions of dollars; and of course with the development of our resources and the general increase in values, this fifty million dollars will go on to the hundred and fifty million dollars, because I believe North Carolina is just now in the infancy of its development. It was an inspiration to the people of North Carolina and to us here—because I speak for a very progressive city—to know that you gentlemen could band yourselves together in this work, realizing that the duties and obligations which your fathers owed to the State and the Nation and the world was a limited one as compared with the obligations and opportunities that you have this day to perform. Mr. Wilson, in a recent address, stated that 50 per cent of all the gold in the world was now in the coffers of the United States vaults; that if this war should last another year, perhaps two-thirds of all the gold of the world would be in the United States. The Minister of Finance of France, in a recent address, said that the total cost of the war up to the present time was something like one hundred and forty billions of dollars, and if it should last fifteen months longer that every nation engaged in the war would be bankrupt.

North Carolina has had a very distinguished and important part pressed upon her in the great arena of the world's activity, and I am glad to say to you here today that to a man she has played well her part, not only in the arts of war, but in the paths of peace, and in this reclamation of our land, which at the last is the State's best resource, you have played well your part, so that you can further not only this great work, but encourage others to achievement when their attention is turned to other things, which have helped not only North Carolina, but the Nation as well, through constructive citizenship.

Will you permit me, in conclusion, to say that you gentlemen in this work have been of inestimable benefit to the State, and it is through your efforts

that a great work has been accomplished, for North Carolina did not take it up until you conceived it and carried it out. May I call your attention to an observation of Isaiah, in the 35th chapter and 1st verse: "The wilderness and the solitary places shall be glad for Thee, and the desert shall rejoice and blossom as a rose." It is a great work that you are engaged in; may you keep it up, and Greensboro and her business men bid you Godspeed.

ADDRESS OF WELCOME ON BEHALF OF GUILFORD COUNTY

MR. W. C. BOREN, Chairman Board of County Commissioners:

Mr. Chairman, Miss Berry, and Gentlemen: I am glad I came last on the program, because you won't expect to hear much from a plain countryman after two distinguished lawyers have spoken. I only wish to say we are certainly pleased to have you with us. We know the importance of this great work, and are glad to see it going on. Guilford County has not done much in that direction, as in the drainage of the larger districts of the east; in fact, we have not many in that shape. While you are here we want to show you some of our good roads and factory places, etc. We will be very glad to have you go with us over Guilford County, and will do all that we can to make it pleasant for you.

RESPONSE TO ADDRESS OF WELCOME

P. H. JOHNSON, President, North Carolina Drainage Association:

Miss Berry, Gentlemen of Greensboro and Gentlemen of the Convention: I would ask for no pleasanter duty than that which devolves upon me as President of the Association to respond to the kind words of welcome with which we have just been greeted. I am grateful for the opportunity which this Convention presents for me to visit your good city and come in touch with your representative men. I wish that I might be able to express our appreciation of your kindness in words as graceful as those which have been employed by the distinguished gentlemen who have preceded me, but being only an humble farmer, I find myself very much like an Armenian who entered a northern university. He understood English pretty well, but he could not always find words to fit his ideas. When he had an idea he could not express, he would say, "I know, but I cannot express." One day a professor asked the question, "What is a vacuum?" He looked up hopefully, and said, "I have it in my head, but I cannot express." That is my position this morning; but I say to you, gentlemen of Greensboro, that in lending your presence and your aid and your counsel to this Convention, you are emphasizing a spirit which is characteristic of every true North Carolinian today, in that you are teaching us that you recognize that community of interest which prevails throughout the commercial, professional, social, and religious life of our State. We have recently seen a striking illustration of the fact that North Carolinians regard themselves as their brothers' keeper. When just a few months ago the mighty waters defied man power to bind them, and swept with such fury over fertile valleys and happy hillsides, carrying desolation and death in their wake, it was good to know that there was not a man of any station in North Carolina whose heart was not touched with sorrow on account of this appalling calam-

ity. It is good to believe that in this instance sympathy was not confined to any creed or condition. The simple toiler mingled his tears and his prayers with those of his more favored brother, and the sympathetic heart-throb in the bosom of the western mountaineer found echo in the bosom of the toiler by the sea; and when a call for aid was issued, it is good to know that North Carolinians responded with a unity of purpose unequalled perhaps since the days when our Confederate soldiers came home bereft of everything except courage, and faced the desolation which war had made, but with the determination to restore to the State her former glory—that State for love of which they had sacrificed their all.

My friends, to my mind this is a momentous occasion in the city of Greensboro. During the course of events I know that you have entertained a great many conventions. I know that many of them in point of numbers have been greater than this one; but I feel safe in saying that you have never before entertained any convention that was so fraught with possibilities for the development of our State, and so broad in its scope of usefulness as is this little assemblage that you have with you today. We come to you with a key which will unlock a storehouse of wealth in North Carolina as broad as man's conception and as deep as the limit of human endeavor. We offer the solution of a problem which has vexed our farmers in this State since its earliest history. We suggest a method of controlling our rains so that they will be showers of blessings indeed. Have you ever thought what a great power water exercises over the prosperity and development of our State? Every year thousands of pilgrims come within our borders to gaze upon the majestic ocean and to bathe and fish in its waters, and to sail upon its restless bosom. These pilgrims are come to see, but many of them pass the winter and remain to enjoy the blessings of health, climate, soil, and beauty with which the God of nature has so wonderfully endowed us. Countless other thousands of men fish in our inland sounds and rivers, earning a livelihood for themselves and supplying our tables with delicacies that would tempt the very gods. Our inland waterway, when built, will link the northern markets with the calm southern sea, and in the event of either war or peace will furnish a channel through which boats of light draft will pass in perfect safety; while ocean, canal, rivers and sounds combine to furnish an avenue for a commerce which is fast making our coast cities rich and powerful. From out of the heart of our western mountains tiny springs start on their eastern journey, bearing with them the rugged strength which they have inherited from the hills which gave them birth. Stronger and stronger these streams become until by the time they reach Piedmont North Carolina it is but the sport of a mighty giant for them to turn the wheels which run your mighty mills, furnishing light and heat to your cities and blessing your surrounding country. It is a fact that these streams, after gathering the latent power of the west, have laid it at your feet. Small wonder, then, that your country has blossomed like a rose, and that your cities have become rich and powerful. These streams have continued their eastern journey, and they have beautified and blessed the country through which they passed until they reached our east, and then they paused for a rest before they reached the sea, and, instead of becoming a blessing, they became a curse to our land. We in the east have been somewhat like the man who fell over shipboard. He was telling his friend about it afterward, and said as soon as he reached the water a shark grabbed him by the

foot; and his friend asked him what he did then. He said why he gave him the foot; he didn't stop to argue with the shark. Now, we of the east have stood idly by for centuries and permitted these waters to monopolize lands which are immensely rich, and we never argued the point with them. But in September, 1908, a little band of men met together in New Bern, North Carolina, and organized our State Drainage Association. The purpose of this Association was to promote the drainage of wet and overflowed lands, and to deny the right of these rivers to bless all other sections of the State and then curse our lands with such an excess of water as to make them of little agricultural value. Great as was the vision of these men, heroic as their courage, I have no idea any of them even dreamed of accomplishing in so short a time the results that they have attained. Only eight years have passed since that time, and under the auspices of this Drainage Association our east has blossomed into a land of sleeping opportunity. From out of this wild wilderness we have hewn for ourselves a very Garden of Eden, a garden where slight endeavor yields abundant reward and honest and steady toil yields more than a just recompense.

I am glad, gentlemen, that I have some living witnesses present this morning when I talk about our swamp lands, for I know if you have heard them talk about the wonderful richness of this land, you would want some one to justify the stories. A Yankee once was talking to an Englishman. He said he had killed 999 snipe in one day, and when asked by the Englishman why he did not kill 1,000, he said he thought he had done enough, and would not tell a lie for one snipe. The Englishman said he knew a man who swam from Liverpool to Boston. The Yankee said: "Did you see that man swim from Liverpool to Boston?" The Englishman said, "Yes." The Yankee said, "Yes, you are right there, old man; I am the man who did it, and I have been looking for a living witness to it ever since." I am glad to say that we have living witnesses who are willing to second any statement that we may make about that swamp land down there, and the limit of these witnesses is only measured by the number of people who have seen it. I have not the information at hand which would enable me to tell you just how many acres have been developed, but I know there are many thousands of acres which have felt its influence, and I know in Hyde County there is a great lake, the bottom of which, containing many thousands of acres of land, has been made fit for the habitation of man. I know that in my own community we have something like 125 miles of canals cut by dredges, and they furnish an outlet for something like 125,000 acres of land. We have now three immense dredges, toiling day and night in order that other thousands of acres may be drained and developed. We have just within a few miles of my home 7,000 acres of corn growing on land that a few years ago was only covered with water and forest growth. This land this year has produced from 40 to 45 barrels of corn to the acre, so that we can say that this one piece of land alone, which ten years ago was valued at 50 cents per acre on the tax books, has produced in one year 350,000 bushels of corn. In cutting down and clearing for a new land, we are working an army of men large enough, if trained, to take the city of Greensboro every day, and we have only just begun the gigantic task which lies before us. We have been so successful in the drainage of swamp lands that we have added another phase to our drainage work. It has become more and more apparent that if the fields of North Carolina are to produce their best,

we must establish a system of underdrainage; so that the North Carolina Drainage Association has undertaken this work also, and this interests every section of the State.

Last year at Belhaven we elected a Vice-President whose duty it was to take charge of this particular phase of the work, and knowing him as I do, I feel sure that this Convention will be both entertained and instructed by his Department, and we will hear from him in the proper time.

Now, in view of all that we have accomplished in these eight years, we cannot help but feel proud of our Drainage Association and proud of the law for which it was responsible; but it is with regret that I am compelled to state that dissension has arisen in a great many of the districts that we have established, and frankness compels me to say to you that in a measure this dissension is justified. There are a number of reasons for this, one of which is that these drainage districts are composed of a large number of small estates, all of which have been operated by their owners and drained according to their own peculiar ideas and whims, and it cannot be expected that all these men will agree to surrender the rights and privileges which they have heretofore enjoyed into the hands of two or three men, whom some of them are unwilling to admit are more competent than themselves.

Another trouble is that, unfortunately, we have sometimes, in some districts, secured commissioners and viewers who were not fully competent, and being new and untrained, these commissioners or viewers have made mistakes, and costly mistakes, insomuch as that in a few instances the very life of the district has been jeopardized. Now, these two conditions can be corrected; but the third is perhaps the most vital trouble which we have encountered, and that is that our law, being new, has proved not to be sufficiently elastic to meet the needs which actual experience has emphasized in the field, and it is this problem, the amending of this law, which confronts this Convention today. I shall not enter into a detailed discussion of the changes that I think should be made at this time; because if I do, I would talk so long I am afraid you would do me like a little boy down in my section once did. There was an old gentleman who lived out a few miles from my town, who visited the Sunday school very often. When he came he always began to talk to the Sunday school class, and he would begin by saying, "Well, children, I hardly know what to say this morning," and then would start in and talk about an hour. There was one little boy in the class who lisped, and when the old man began with his usual words, the little boy rose in his seat and said: "For goodneth thake, thay amen and thet down." I will say that we cannot any longer delay the amendment of this law if we expect the confidence of the individuals who live in these various drainage districts, and I trust that all of you have already studied this problem and that in the proper time we will have suggestions, and that out of these suggestions we will devise a law that will meet the needs of the occasion. I thank you.

REPORT OF THE SECRETARY

The Eighth Annual Convention of the North Carolina Drainage Association was held at Belhaven, Beaufort County, North Carolina, November 29 and 30 and December 1, 1915. The meetings were held in the City Hall of Belhaven, and were presided over by the Secretary, Joseph Hyde Pratt, and Vice-President P. H. Johnson, in the absence of the President, Mr. Lawrence Brett.

Since the organization of this Association eight years ago there has not been held a more enthusiastic and interesting Convention than the one held at Belhaven. Twenty-one counties were represented, as follows: Beaufort, Bertie, Carteret, Craven, Currituck, Edgecombe, Guilford, Hertford, Hyde, Lenoir, Mecklenburg, New Hanover, Orange, Pasquotank, Pitt, Robeson, Tyrrell, Wake, Washington, Wayne, and Wilson. There were also representatives from the District of Columbia, Missouri, Ohio, and Virginia. There were 116 registered delegates, 102 of whom were outside of Belhaven. Representatives of various dredging and contracting companies, banks interested in the purchase of drainage bonds, and companies producing tile were present. The Drainage Law was thoroughly discussed, not only by the delegates, but by the bond dealers and contractors, and it is believed that some important points were brought out which will undoubtedly result in the solution of many points of the Drainage Law which have not proven entirely satisfactory.

The officers who were elected for the coming year are: President, P. H. Johnson of Pantego; Secretary-Treasurer, Joseph Hyde Pratt of Chapel Hill; First Vice-Presidents, M. W. Thompson of Greensboro (in charge of District Drainage), Prof. M. E. Sherwin of West Raleigh (in charge of Tile Drainage); Second Vice-Presidents, one from each county represented.

The delegates were taken to visit Lake Mattamuskeet District in Hyde County, on a boat from Belhaven to Swanquarter. The people of Swanquarter and Belhaven provided automobiles for taking the delegates to Lake Mattamuskeet, where they were delightfully entertained at an oyster roast, etc.

The following towns sent invitations for the 1916 Convention: Raleigh, Greensboro, Goldsboro, Charlotte, Creswell, and Lumberton. Advocates for each city presented very strongly the advantages of holding the next Annual Convention in their city, and after considerable debate Greensboro was selected as the next meeting place.

A full report of the proceedings of the Convention has been prepared and the manuscript is now in the hands of the printer, but we were unable to get it ready for distribution before the opening of this Convention.

REPORT OF TREASURER

The Treasurer's report for the year November, 1915, to November, 1916, was read and referred to an Auditing Committee consisting of Messrs E. E. Hunter, W. H. Bullard, and C. A. Statesbury, who reported as follows:

We, the undersigned committee, have audited the inclosed vouchers, and find them to be O. K. with the exception that bill for stenographic services, \$20, dated December 3, 1915, has not been receipted.

APPOINTMENT OF COMMITTEES

The President appointed the following committees:

COMMITTEE ON RESOLUTIONS

John H. Small, *Chairman*.....Beaufort County
Bennehan CameronDurham County

W. C. Boren.....	Guilford County
E. Williamson	Sampson County
W. F. Aberley.....	Craven County
John Wilkinson	Beaufort County
N. L. Cranford.....	Forsyth County
A. E. Hire	Forsyth County
G. B. Sellers	Robeson County
James Slate	Stokes County
Bruce Craven	Randolph County

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

W. D. Alexander, <i>Chairman</i>	Mecklenburg County
V. T. Baggett	Sampson County
J. L. Becton	New Hanover County
M. W. Thompson	Guilford County
D. B. McNeil	Robeson County
J. Slate	Stokes County
Bruce Craven	Randolph County
C. A. Statesbury	Hyde County
J. B. Blades	Craven County
C. H. Jessup	Stokes County
Lovit Hines	Lenoir County

MEMBERSHIP COMMITTEE

Miss H. M. Berry, <i>Chairman</i>	Orange County
E. Williamson	Sampson County
John D. Waldrop.....	Guilford County
C. Bodenheimer	Stokes County

AUDITING COMMITTEE

E. E. Hunter, <i>Chairman</i>	New Hanover County
W. B. Stafford.....	Forsyth County
W. H. Bullard.....	Sampson County

COMMITTEE FOR JUDGING TILE DRAINAGE REPORTS

Prof. M. E. Sherwin, <i>Chairman</i>	Wake County
H. M. Lynde.....	Wake County
F. R. Baker.....	Wake County
H. Cowley	Edgecombe County
T. E. Brown	Wake County

LEGISLATIVE COMMITTEE

John H. Small, <i>Chairman</i>	Beaufort County
A. Wayland Cook	Guilford County
Bruce Craven	Randolph County
Lawrence Brett	Wilson County
P. H. Johnson	Beaufort County

FINANCING OF DRAINAGE IN RELATION TO FEDERAL FARM LOAN BANKS

By PROF. WILLIAM R. CAMP of the North Carolina Experiment Station and Extension Service

Mr. Chairman and Gentlemen of the Convention: The subject I have to talk to you about is one that is very vital to the development of the agriculture of this State, and especially vital to you men in your profession as drainage engineers. No law has been passed by Congress that has meant more to the development of the agriculture of the United States than the Federal Farm Loan Act, and after the farmer, there is no body of men who ought to be more interested in this act, to know its provisions and to help farmers to make use of them, than you drainage engineers. Frequently your projects are held up for lack of the finances to carry them forward. As I understand it, you have in this State a special law providing for the financing of drainage propositions, but so far it has not been possible to exempt the bonds from taxation. The law we are to consider has an advantage over the North Carolina law in that the bonds issued will be exempt from taxation. I shall take it for granted that you do not know especially about the new Federal Farm Loan Act, except perhaps in a general way, and some may not know that. We will endeavor briefly to state what it offers to farmers. A similar law for long-time credit has been in operation in Germany and in European countries for over a hundred years, allowing German farmers to get their money at a low rate of interest, something like $3\frac{1}{2}$ per cent to $5\frac{1}{2}$ per cent, while the American farmer has paid so far for his interest on his loan something like $8\frac{1}{2}$ per cent on an average.

We have banking institutions in this State in plenty, perhaps too many; but I am going to tell a story of what a banker told me to show the inability of the banks to make long-time loans for the development of agriculture. A friend of his came to borrow \$6,000 on a piece of land which he wished to purchase. The banker told him: "I cannot lend you that money." His friend said: "Come around and look at the land, anyway." The banker went around and looked at it, and said: "Why, the timber alone on this land is worth \$6,500! Yes, I will lend you the money." This man wanted the loan in the first place for agricultural purposes, and for that purpose he could not borrow the money from the bank; but the fact that there was \$6,500 worth of timber on the land made the banker look at it in a different light. This shows that bankers are ready to make loans for short-time purposes for business development, but for agricultural development over a long time they are not willing, because they have to lend primarily demand deposits; that is, they have to lend primarily not their own capital, but the money which depositors have put in the bank, and which they may wish to draw out at any time. Banks cannot afford to lend these deposits over a long period of time. As a result of this situation, we have a great agricultural State awaiting capital for its development. Men that have spare money would buy land, but the banks have no money to lend for its long-time development, and at most can only lend it for a year, with privilege of renewal. While the land in farms for the total area forms 46.2 per cent for the United States and 71.9 for North Carolina, still the per cent of land in farms which is improved is 54.4 per cent for the United States and only 39.3 per cent for North Carolina. These figures show that a large per cent of our land is in farms, but a small per cent of the

land in farms is under actual cultivation—in fact, the smallest per cent for any State in the South Atlantic States excepting Florida.

Now, briefly, just how is the new Federal Farm Loan Act to bring in new capital? In the first place, the law provides for the establishment of a Federal Farm Loan Board appointed by the President. This Board is to divide the United States into twelve Land Bank districts. Each district is to have a loan bank, and in order to have a loan bank there has to be a capital of \$750,000. This capital is either to be subscribed by farmers or by the Government. If the farmers do not subscribe the whole amount, the Government has to subscribe the capital, so that it can insure that the bank will be started, and these Land Banks, twelve of them in the United States, can lend money up to twenty times the value of their capital, or \$15,000,000 for each Land Bank district. Fifteen million dollars will be the minimum that a Land Bank can lend as soon as the farmers own all the stock.

How is the farmer to take hold, how is he to come in? In order for the farmer to borrow money, he not only has to furnish proper security, but he has to become a member of a National Farm Loan Association, and there have to be at least ten members, and they have to borrow at least \$20,000. When you have an association of borrowers like this, they may apply for a charter from a Federal Land Bank. To have an application favorably considered, the security of the land has to be twice the value of the loan the farmer wants to secure. If he wants to borrow \$1,000, his security must be land worth \$2,000. The value of a piece of land should be based largely upon its earning capacity. Improvements do not count unless they are insured, and then loans may be also made upon one-fifth of the insured value of the improvements. Now, this applicant for \$1,000 cannot use it for speculative purposes, so that you might say that in so far as your drainage propositions are speculative, just that far the Federal Farm Loan Act will not help you at all; but in so far as your drainage projects are promoted by farmers who want to borrow for the development of farming, for the purchase of land which the owner wishes to improve and farm, or for paying off an already existing mortgage on the land, then the money can be secured under this act.

The interest rate cannot be more than 6 per cent. The farmer can have any length of time from five to forty years to pay his debt in. To illustrate: if a farmer wishes to borrow \$1,000 and use part of it to pay his pro rata share of drainage expenses for his district and his share for the clearing and drainage of his own particular piece of land, or for its tilling, he could borrow the \$1,000 for twenty years by forming an association of ten borrowers. If the rate of interest is 5 per cent, the payment upon interest and principal would amount to \$80.24 for each year. You see that this is only about 8 per cent for the payment of the interest and reduction of the principal. If the borrower makes his loan for a longer time than twenty years, the payment upon the principal would be less. After five years, if the farmer has done so well that he desires to pay the whole amount up, he would be free to do so in any amount which is a multiple of \$25. In brief, the advantage of the law from the farmers' point of view is: a low rate of interest and easy terms of payment. There need be no fear of foreclosure. The farmer can go ahead and develop his land and gradually pay for his land or improvements out of his earnings.

To explain the organization of a National Farm Loan Association, let us assume that we have here ten farmers who want to borrow on an average

\$2,000 apiece or \$20,000 altogether. Their mortgages covering the loan must be worth at least \$40,000. To borrow this amount each of the farmers has to join a National Farm Loan Association and make application for a charter to the Land Bank of the district. The Division of Markets and Rural Organization of the North Carolina Extension Service, West Raleigh, N. C., is cooperating with the Federal Farm Loan Board to help farmers organize free of charge. This Division has furnished organizers to show the advantages of the law and to help farmers take the first steps toward forming a National Farm Loan Association. If the application for the association just assumed is approved, bonds are issued on the mortgages of the individual farmers.

Each farm loan association has to sign the note of the individual farmer, so that it becomes responsible for the payments of each individual farmer's loan. Now, to assume that responsibility the National Farm Loan Association has to have a loan committee of three men, who pass on each application for a loan, to see that the security is sufficient. To back up this loan and really make this committee do its duty, each borrower has to take 5 per cent of the value of his loan in stock. For instance, if he wanted to borrow \$1,000, he would take \$50 in stock in his local association. While the farm represents a security to the loan, yet you might say this arrangement makes each member of the loan committee interested in doing his duty. Each member of the loan committee is a borrower, and as such he is liable for any defaults to the extent of 10 per cent of his own individual loan. The question arises as to how far members would be liable under the worst circumstances. Under the European law loan associations sometimes have unlimited liability, and they find it does not work harm, because it really adds to the assets that form the security for borrowing. They say it really increases the borrowing power and lowers the rate of interest, so that instead of in reality adding to the risk of the individual borrower, it lowers his rate of interest. In this country we had an idea that American farmers would not stand for unlimited liability, and so we have limited the liability of each borrower to 10 per cent of the value of his loan, or once over the value of his stock. It is the same liability that you would have if you should buy stock in a National bank: you would be liable for your stock and once over. If you take stock in the farm loan association, you are liable for your stock and once over. Another interesting point is that no farmer has to put his hand in his pocket to invest in stock. He can take part of the money he borrows and pay for that stock. The stock is an investment which draws interest, but which must cease when the farmer ceases to be a borrower. The stock forms part of the last payment on the loan. Thus the security for the repayment of loans is of two kinds: (1) the mortgage of the borrower and (2) the stock owned by the borrower. The stock form of security makes all members, whether of the loan committee or not, interested in a conservative valuation of each farm and also in seeing that the money borrowed is used for the purposes specified in the loan contract, that is, for purposes which shall enhance the value of the security offered by each member.

In addition to the appraisal by the loan committee of the local National Farm Loan Association the Land Bank sends out an appraiser to value the land. If on appraisal the applications are all granted, or if some of them are cut down, and you have still \$20,000 applied for, your charter will be granted, and then the mortgages of this association and other associations

are entrusted to the Land Bank Registrar, and the Land Bank, upon the approval of the Federal Farm Loan Board, issues bonds upon these securities for not less than \$50,000 at a time.

This whole system is rather a complicated one, but there are only a few things that the farmer has to understand. First, you have the appraisal of the local committee, and this appraisal is submitted to an appraiser of the Federal Land Bank. Moreover, every Land Bank is liable for the payment of the bonds to the extent of the *pro rata* share of its own borrowings. That is, it could not be required to pay all the failure of one Land Bank, but all the Land Banks in the United States would have to pay their share of the failure of one Land Bank. With all this machinery to guarantee that the security for bonds shall be sufficient, the security of the individual farmer is established, so that it can have currency at any place in the United States. Thus Tom Jones down in Duplin County may desire to borrow money. A lender in Massachusetts, Illinois, or California need know nothing about Tom Jones or his earnings, whether he is shiftless or thrifty. The Federal Farm Loan Board takes all this worry off from the lender so he can sleep on his bonds and be content to lend at a low rate of interest, because his security is safe beyond question. The Federal Farm Loan Board provides all the machinery of inspection to guarantee the security of all loans. The Federal Farm Loan bonds, like Government bonds, are free from all taxes, either Federal, State or municipal. Not only that, but these bonds are considered as legal investment for trust funds, and proper security for public deposits and appropriate investment for the Federal Reserve Banks. Thus the Government has established them on the very highest basis, and their sale is going to be different from the sale of your drainage district bonds, because they have the security not only of that local district, but of all the districts in the United States. This combined security makes the loan gilt-edged, so that the investor may sleep overnight and give no thought to the security that is going to make this bond one of the most attractive investments to every one in and out of the State. For instance, if you have \$25 you want to loan, or \$50, or \$500, or \$1,000, you can buy these bonds, and while you cannot hope to get more than 5 per cent, yet that 5 per cent would be net. There would be no tax on it, so that this is going to be an attractive form of saving and permanent investment. The States of Massachusetts, New York, and Connecticut alone have two billion and a half dollars in savings, and the bonds of the Federal Land Bank will give the lenders in these States a most conservative form of investment.

One other advantage that I would like to mention: One of the greatest of all weaknesses of American farmers is their unwillingness to coöperate; it is every man for himself. Take the American farmer individually, and there is no better or more intelligent group of men in the world than they; but when it comes to coöperative action, team work, working together with one another, doing a thing together which may be of common interest to all, but which the individual farmer is helpless to do alone, there is no weaker group of men in the whole world than the farmers. Europe has been learning for years the value of coöperation. The majority of the farmers in this country have not. This law will have for one of its main effects the establishment of coöperation among the farmers. It will reduce the cost of appraisal, reduce the cost of legal fees, help to introduce the Torrens system, help them to feel

mutually responsible in their own appraisal, and help to do away with some of the suspicion which has developed in the American farmer as a result of his isolation. Thus one of the best results of this law will be the development of a spirit of coöperation, whether in the establishment of a drainage district, or helping the farmers to market their products, or to come together for any social or economic advantage

MR. JOHNSON: I am sure we are very grateful to Professor Camp for the very instructive and interesting talk he has given us, and he has kindly suggested that we might be permitted to ask some questions:

QUESTION: You referred to Tom Jones just now. I wondered what would happen to Tom Jones if he sells that land while the mortgage is outstanding?

ANSWER: It would be the same as any other mortgage. The obligation would be passed over to the person who buys the land; he would be released.

QUESTION: What governs as to whether the interest shall be 6 per cent or a lower rate?

ANSWER: It will depend upon the sale of the bonds. That is one reason I gave so much time to the system that has been developed to make these bonds gilt-edged. If the public will only see it, behind each bond is not only the collateral put up, but it has been appraised by the Land Bank district appraiser; and not only the Land Bank is liable, but all the Land Banks are liable for the payment of the bond. The farmer will not have to pay more than 1 per cent over the price the bonds sell for. If the bonds sell for 5 per cent, a farmer will have to pay 6 per cent.

QUESTION: You estimate that 1 per cent will pay the cost?

ANSWER: The cost is limited to that.

QUESTION: How is that 1 per cent returned to you?

ANSWER: The rule is that the rate of interest shall be only 1 per cent more than the latest bond issue.

QUESTION: The initial borrower pays 6 per cent; later it may bring 5 per cent.

ANSWER: At the end of five years he can change from one issue of bonds to another, and get the advantage of a lower rate of interest.

QUESTION: Under existing conditions, if I borrow \$1,000 and give a mortgage on land, then I sell it afterward, the only way I can be released is to have that mortgage cancelled and a new mortgage issued. In this event, if I borrow some money for, say twenty years, the only thing I can see would be to pay the whole thing off when I sell. In that event, if I sell the land within five years, what shall I do about the mortgage?

ANSWER: The application would be passed over to the man to whom you sell.

QUESTION: Would it be possible to make a loan on these swamp lands? Would that be considered good collateral for a loan?

ANSWER: That will be one of the difficult problems of appraisal. It has not an earning capacity as yet.

QUESTION: If they wanted to raise money to put through a drainage project, would they be able to do that through a Land Bank?

ANSWER: I think they would, although I do not know just what would be the policy of the Board. I wrote up to the Federal Board to get some ideas as to what their policy would be in regard to drainage projects, but have not received an answer.

QUESTION: Did I understand you to say that where a drainage district had already been organized and bonds issued against this property, it would be impossible to borrow money from these banks on this property until after these bonds are paid?

ANSWER: The Government allows no loaning of money on second mortgages. That mortgage would have to be taken up with part of the money borrowed.

QUESTION: Suppose one of these ten men should default in his payment, would the other nine be responsible?

ANSWER: If a man defaults in one payment, or if he defaults on his loan, the balance who go into the Association would be responsible, but they could foreclose that man's mortgage for their protection. That makes it necessary for your Loan Committee to see that the collateral is there. I might say a word, in passing, as to how you men might help farmers get started. Sometimes it is hard to get a bunch of farmers to act together, and so we have got out individual application blanks for a loan. Already there are over sixty Associations which have been formed, and a good many have been formed by the farmers themselves. This has all been done since the first of September. The loans applied for amount to over three million dollars.

MR. SMALL: This discussion has brought up a very interesting phase of our Drainage Law. Now, the present law provides that a district is established and the share of each landowner is fixed; he may pay in cash the amount of his assessment, which would be a saving to him; otherwise the proportion that has been fixed against his land as the cost of drainage is divided into ten annual installments, the first installment on the principal not being due until three years after the district is established; but there is no provision under the law at present by which a man who elects to pay his proportion of the drainage liability, or by which he may pay up in one lump sum; so that in view of the possible

application by many landowners for loans under the Federal Farm Loan Act, they will be confronted by the difficulty that here is a first liability on their land running over a series of years. If they have paid one installment on this liability, it will not be possible for them to take up the balance until the whole series runs out. This loan must be a first lien on the land that might prevent him from borrowing from this Federal Loan Bank, and there would be no method under our present law by which he might pay in advance, except, of course, by paying the balance he owes, plus 6 per cent interest for every year over which the drainage bond should extend; so that it is well to consider an amendment to our drainage law by which a man can pay up what is due, plus some slight sum as a compensation for his withdrawal from the payment of interest, so that he can take advantage of the Federal Farm Loan Bank. I just suggest that because it is pertinent right here.

DRAINAGE IN THE PIEDMONT SECTION

By W. D. ALEXANDER, Drainage Engineer

Along the water-courses of the Piedmont section are bottom-lands of varying widths. Upon these lands the early settlers and their descendants depended for their corn crops. As the hills have been cleared and allowed to wash away, the crooked channel of the stream began to give trouble. This gradually filled up and became more subject to overflows. The chance of harvesting a corn crop became less each year, until about forty years ago, when the owners began to abandon their bottoms. Many of the farmers tried to straighten the channels and cut new hand ditches for the streams. This answered for only a few years, because not enough of the farmers acted together and the ditched stream was not long enough to protect itself; rafts, logs, etc., were allowed to collect and soon caused the ditches to fill up. Furthermore, ditching was so expensive that it was discontinued.

The first drainage district was organized in this section about seven years ago. The commissioners bought a dredge and employed operators and did the work themselves. The farmers of this district have harvested six very fine crops of corn from their bottoms. Immediately following this district were others, until now there are more than forty of these districts that were in swamp now raising crops of corn. There are about fifty thousand acres of this land that can be classed as reclaimed land—absolutely worthless before dredging, even a menace to the health of their communities, as they were breeding places for malaria and mosquitoes. These bottom-lands are extremely fertile, being built up with the washings from the hillsides; they produce very large crops of corn. The reclaimed lands of Piedmont North Carolina produce annually over two million bushels of corn. In addition to this, the health of the community is largely improved. Some drainage enthusiasts claim the saving in doctors' and medicine bills are enough to pay for the drainage.

The average cost per acre of reclaiming land in this section is, for the draining, from \$15 to \$30 per acre. This land, when put into cultivation, will sell for \$100 an acre.

In talking dredging to interested parties, their first question is, "Will it last or will it fill up in a few years, as the streams did in the past?" I answer that this way: I know ditches that have been standing for five years that are in better condition today than when they were dug. I also have seen some that were allowed to go to pieces in a very short time. It is impossible for man to make anything that does not need attention, and a ditch is not an exception to this rule. These swift-flowing streams have a tendency to bring down large quantities of sand; as much as possible of this sand should be kept out of the ditch and the ditch should be so designed as to carry away the sand that is brought to it.

The engineers who first began drainage in this section made the dredged channel follow the old water-course except to make some few cut-offs. They later tried the swamp style of ditch, or what is called the "Paper Survey," which is to make a survey of the bottom-lands and map it. On this map mark out the proposed ditch as straight as possible; then locate this ditch line on the ground. It has now been found better for the engineer to stake out the ditch on the ground, paying especial attention to the kind of soil he is crossing, avoiding deep sand banks and rock ledges, giving due consideration to the old channel, a straight channel, and the general location of the new channel.

There is a general belief among districts that experienced engineers and contractors are a needless expense. They think a county surveyor can run around the bottom-land and ascertain how many acres of land are in the district. Then the commissioners can buy a second-hand dredge that some neighboring district has used, employ a dredge runner, and have the job dug for half what it would cost if they had employed a drainage engineer to properly lay out the desired improvements and let the work out to a competent contractor. I agree with these people that they can have the work done this way cheaper; but what kind of a ditch will they have? They will have a ditch that is improperly located and designed, no berm, dug with a machine that is not suitable for that size ditch; the banks will cave and the entire work will be unsatisfactory. Before two crops of corn have been planted all of the property owners are mad at the drainage commissioners who, by false economy, saved them half the expense of ditching. It is possible for the district to buy a dredge and do the job themselves if they have a first-class drainage engineer to visit the work every week and will do what he says.

Following are some of the advantages of having a competent drainage engineer on the work: He is of service in the preliminary survey, being able to tell whether the work should proceed or be abandoned. His greatest value is in the survey and final report; under no conditions should a district be dredged unless it has been properly staked out. In the letting of the contract he will save the price of his services, as contractors will bid closer if they know what is to be required of them. Bond buyers want a district in the hands of a drainage engineer, if they are to handle the bonds. The contract is not completed and the contractor should not be released until the work is passed upon by an engineer, as many defects will escape notice unless they are looked after by an engineer.

Drainage has just started in this section; every stream needs it; and whenever a district is properly drained it is a source of inspiration for all of the landowners in a radius of 25 miles to organize their swamps into districts. However, if a district is not properly ditched and the work is unsatisfactory

to the landowners, who have profited by the first cost, it is a hindrance to all work in that section of the State.

Let us all who are interested in drainage see that the work is efficiently if not so economically done. Let us impress upon the commissioners that they must have a maintenance fund or else trespassers will cut footlogs. These will collect rafts which will soon be islands and fill up the once beautiful canal.

PIEDMONT DRAINAGE

MR. N. L. CRANFORD of Forsyth:

Mr. Chairman, Ladies and Gentlemen: A few days ago I received a program from Dr. Pratt, and noticed my name on it. I had written Dr. Pratt that I was unable to talk in public, and that we had not actually accomplished anything in the drainage line in Forsyth County. We have been trying to organize a drainage district in Forsyth County for three years. I have gotten into the Superior Court twice, and out, and am now back again. When I first took up this project there was not half a dozen men in Forsyth County who ever saw a dredge. I took the project up with Mr. Prince, and we tried to interest the farmers in it, and took a bunch of them to Iredell County, trying to convince them that drainage was a good thing. The trouble was we could not get the opposition to go. I do not know when I will get a district organized. We have some valuable land in Forsyth County which, if drained, would be a great deal more valuable, and we hope in the course of time to get a district organized over a distance of about 24 miles. We had Mr. Alexander go over this district, and also Mr. Lynde, and talk to the farmers. I hope this Convention will tell us how to organize that county. We presented our petition nearly three years ago. We took the proceedings through the court, before the clerk, then took an appeal once to the Superior Court, which was sent up to a referee. We had 110 petitioners, with 85 appellant defendants. A few days ago it came up again. The clerk of the court found that we had a majority, and ordered a survey. They appealed from that, and it is back now in the Superior Court again.

MR. ALEXANDER: One of the principal things they appealed on is in our preliminary report we did not show how far the ditch would go on the tributaries. The lawyers contend that we should have gone on up those streams six or seven miles. To bring these in, we would not have a majority on the petition. It is usually customary in the Piedmont section with our preliminary report to make a very preliminary map. We just use a Government soil map, or something like that, and in this instance we used a map made by Mr. Lynde, and we only showed on that map where the drainage would begin and where end. We were supposed to go as far as high water would strike, but did not show how far up on the branches.

MR. JOHNSON: I want to say that I am exceedingly glad to have Mr. Cranford here today and to have heard what he has said. There is one thing about this North Carolina Drainage Law and that is that in the end

it will surely organize a drainage district if it is a feasible proposition. It may take a little time, but we are able, as a rule, to show the people. The strongest point in our law lies in the fact that if you have a majority of the petitioners or ownership of land, you can force individuals in, whether they want to come in or not, and the only trouble I have seen has been in the fact that people in starting these new districts do not always conform with the exact letter of the law, and in a number of instances it has been necessary to go back and start again. If you will comply with the law, I am not afraid but what you will get a drainage district. I know of a big drainage district that was held up because it was a piece of property belonging to a number of individuals, and notice was served on only one of them. These little technicalities can delay the proceedings. If you look after the legal end, there is law enough to bring them in. In our district we had a strong corporation to fight all the way through, and we afterward came to a compromise with them.

REPORTS ON DRAINAGE DISTRICTS

MR. P. H. JOHNSON:

Broad Creek Drainage District.—The work on this district is practically completed. We lack something like half a mile now of all the ditches being cut. A great many of these ditches have been gone over for the second time. There is now between five and six thousand acres of new land to plant to corn this year, and there will probably be a larger amount cut down during this spring and planted next year; so that I believe we will have at least twelve thousand acres planted in corn next year.

Conaby Creek Drainage District.—This has never amounted to anything.

Jackson Swamp Drainage District.—In this district the work is about completed. It is a small district, but it has opened up some very valuable land. It was largely established to furnish an outlet from lands already cleared. The swamp in this was not so dense, but the soil is good for general purposes.

Pantego Drainage District.—This was the first to be organized in the State and the first to begin actual work. We have had our work practically completed now for about four or five years. Our bonds are about six years old; we have paid interest three years, and have seven years more to complete the payments. I reckon that district has had a more varied experience than any other district in the whole State. We had peculiar conditions. We came into a town and took in part of it. We cut canals, one of which was eleven miles and the other thirteen miles. We drained about 16,000 acres of land, and the 11-mile ditch is an outlet and the 13-mile ditch is an intersecting canal that was designed to drain the water from something like 60,000 acres of land above us from overflowing our land after we had provided an outlet. I am sure the land in that district, taken as a whole, has increased in value over 400 per cent. I know that is a conservative estimate. There is not in that district an acre of cleared land that could be bought for less than \$100. There is not an acre in the woods that can be bought for less than \$30, and I can easily remember when that land was valued for taxation at 50 cents per acre, and

we had not more than half of the exact acreage on the tax books. If you people, those of you who have never been into eastern Carolina, would come down there and look at Pantego and Broad Creek Drainage districts, and see the wonderful results that have been accomplished there, if Mr. Cranford could get his people to look one time at these results, I would guarantee that he would hardly have a dissenting vote when it came to the establishment of his district.

I was out in Ohio once, and we had some samples of soil out there. We had a miniature pasture showing cotton growing in this soil. There was a man who came to me and called me off privately and told me that of course he recognized the fact that we had a good exhibit there, and he felt proud of it as being in the United States. He had never seen anything as good as that, taken as a whole. He said: "Of course, I know that samples of this came out of some rich spot in a garden or some place that has been specially fertilized." I said: "If you will come to my town, I will take you out in the country, and if I do not show you thousands of acres of land just like this, if I do not show you crops just like the crops we are exhibiting here, I will pay all your expenses down there and back." Two weeks after that he came to Belhaven and I showed him the soil and the crops about on the land. I asked him, "Now who pays expenses?" He said, "I will have to pay my own expenses." That man went back home and returned to Belhaven and bought 600 acres of land in that vicinity. We made some mistakes in establishing our district, and it cost us more money than perhaps it ought to have cost us; but I am sure—and when I speak for myself, I speak for all other districts—that drainage is worth four times what it cost; and as I said this morning, when we have cleared and drained all these swamp lands (and we are going to do it) we will make North Carolina the greatest agricultural State in the Union. I have studied farming conditions all over this country, I have knocked about a good deal, and wherever I have gone I have made it a point to look at the land and the crops, and I have seen places where they can grow as much corn or as many potatoes to the acre as we can. I have seen places where they can grow as much cotton to the acre as we can, but I have never seen any place anywhere in any State where the same acre of land will produce as large a yield of all these various crops as well as North Carolina. And this is a big problem that we have before us. I cannot too strongly emphasize the necessity of so revising our drainage law that it will meet the exigencies of the occasion. I have been a member of three different legislative committees, and we have spent a great deal of time considering this law. Mr. Small and Dr. Pratt have spent weeks studying the law and the revival of it, but the question that came up this morning has never been raised before. We must have these amendments right now, and I hope you will favor us with any ideas you may have formed during the next session of the Convention. .

Pantego River is also in Beaufort County, and I will say that work is practically complete, and the conditions are just about the same as the others, except that there is more land developed. The land is being developed very rapidly in the Wenona section.

In regard to the old rice lands, would say that ten years ago we had bought a farm that was killed entirely by rice twenty years before that time. We could not get it to produce anything. This land grew broomstraw and nothing else for twenty years, and was not cultivated. We bought that farm and

thoroughly ditched it and limed it, and Mr. Kerr in Raleigh was kind enough to say to us that we had the nicest farm in the State now. That land has been cleared now about ten years, and yesterday I was picking 120 bushels to the acre of Irish potatoes in that field. This spring we had a similar yield. We usually make ten barrels of corn to the acre and push a bale of cotton.

J. L. BECTON:

New Hanover Drainage District No. 1.—This has been completed about twelve months. Not only in an agricultural way are they reaping great rewards, but it has developed a suburban territory. Homes are being built upon it. Already thirteen have gone up, each of which represents an expenditure of from two to four thousand dollars.

New Hanover Drainage District No. 2.—On this the preliminary report has been prepared and handed in, and we are now ready for a final report. The same is true of New Hanover District, No. 3.

Little Coharie Drainage District, Sampson County.—This was the first district to be tried in our county of Sampson. We had had no experience. We went ahead without the assistance of an expert attorney. We did not follow the letter of the law, you know; our clerk of the court was not a lawyer and did not realize the necessity of following every detail. We thought everybody in the county would surely be in favor of drainage, and did not summons to court everybody connected with the district. We did not notice that ourselves, and when the report was filed our opponents had a notary and stopped us. The clerk of the court was going to give us another meeting, but we stopped right then. Before we made arrangements to go on with the proceedings, the petitioners filed an injunction for the bill of costs. We have never made a start since.

MR. JOHNSON: I want to say you have mentioned a thing that is vital in the establishment of a district. The first thing to do is to employ the very best attorney available, and the next thing to do is to employ the best engineer available.

Brown Creek Drainage District of Anson County.—Never organized.

Cabarrus Drainage Districts, Nos. 1, 2, and 3.—Reported completed by Mr. Alexander. No 4 has had surveys made. Have not got it contracted. District is too short.

MR. W. D. ALEXANDER: I was engineer of Coddle Creek, or Cabarrus County Drainage District, No. 3. The work has been very successful. In the Piedmont section it costs more to drain, from \$15 to \$25 per acre. After draining, the land is worth from \$100 per acre up. I knew one tract to sell for \$100 per acre, and the purchaser paid the drainage tax.

Cabarrus Drainage District No. 4.—This has been started, but the acreage is so small I do not think they will ever let the contract.

Buffalo Creek Drainage District, No. 1, of Cleveland County.—Has been completed.

MR. N. L. CRANFORD: We have three districts in Forsyth County and two have been nonsuited. The one we have I suppose would be called the Middle Fork, South Fork, and Muddy Creek Drainage District.

Mecklenburg County Drainage Districts, Nos. 1 to 8.—Reported by Mr. Alexander as completed. No. 9 uncompleted.

DR. PRATT: In regard to this drainage in the Piedmont section, I want to say the first district started on Clark Creek in Catawba and Lincoln counties back in 1908 or 9, and it was before the drainage law was passed, and it was done by individuals. They did their own dredging, etc. We made an examination of the district, and worked out what it would cost. There was a meeting in Lincolnton, we asked if they could pay \$19 per acre for drainage, and they said, "Yes; we will pay \$25 if you will guarantee that the ditch will take care of the water." The engineers from Washington went over the ditch and said they thought it would. The first year after the work was completed they had one of the heaviest rainfalls that they had had in years; the people from the surrounding counties went over expecting to see everything carried away, and instead of that they found that the water had been taken care of, even under excessive rainfall. Seeing is believing and they went back and started work in the adjoining counties.

AFTERNOON SESSION

MR. M. W. THOMPSON, presiding: It has occurred to us that possibly some gentlemen have come in on the noon train who could make a report on some of the districts about which we have not had reports.

MR. SELLERS:

Back and Jacob Swamp Drainage District.—We have our district completed. It has given very satisfactory results. We have had it completed about three years, and a good deal of land has been cleared in the district. Some of the land which was utterly worthless sold for \$40 to \$50 per acre. Before draining, it was not worth \$5 per acre. We paid our first assessment last year, and had very little trouble in collecting the money.

MR. ABERLY of Craven County: Mr. Blades does not treat me right. Here I come up here more to learn than to say something. I was glad for that report this morning, in which the plan had been given us how to help ourselves a little better than the present law provides for. Up near Dover they finished a canal a year or so ago. Last year it was a very hard matter for these people to make up their assessments. In fact, I have seen a lot of property advertised for sale by the Association. That is a matter that causes more or less hesitancy for those that have

lands that ought to be drained to enter into schemes of having it done. It seems to me in order to put us people in the east in shape that we can help ourselves, the present arrangement of 10 per cent looks to be mighty heavy. If a body can drain his land and find a ready purchaser, or quick purchaser, or can convert that land quickly into earning power, it would be all right; but it seems to me we ought to be planning for giving the people a longer chance to pay these assessments. I know that right around New Bern they started a movement about a year ago, but it died, as we heard this morning of other places that died, and it seems that that part of it is more or less in the way. People are afraid to enter into such a big obligation. Our eastern section has so much swamp lands, and when drained to be carried on to success, it is necessary to drain many times such big areas, and the property owners that own these lands, unless they can find buyers right away, it puts them in an unwarranted position. I do not mean to discourage this work. I think we should arrange for legislation so that the work can be carried through.

MR. BLADES of New Bern: I think the State law can have nothing to take its place, and I am very much in favor of it. The Farm Loan plan will do lots for drainage. I believe that it will work out for the good of the farmers.

I was recently driving down what we call "Oriental way." I heard of a clearing that was very rich. I drove quite a distance. This has been drained by private enterprise entirely. I asked the value of that land. They said, "You cannot buy any of this land for \$100 or more." Other land near by was selling for \$10 per acre. This land, when drained, has such a deep soil that it is exceedingly productive for any number of years.

MR. THOMPSON: I notice our Secretary has assigned practically all the afternoon to a discussion of the North Carolina Drainage Law. For today's discussion we have a gentleman with us who has been at every drainage meeting of this Association, and he has had a large part in the formation of the law under which we are now working. He is a man who is known largely throughout the State. I do not feel that John H. Small, Congressman from the First District, needs any introduction to this audience.

REPORT ON BIG COLD WATER CREEK DRAINAGE DISTRICT OF CABARRUS COUNTY

By J. A. SCOTT, Secretary of District

The Big Cold Water Creek has been ditched and dredged about three years. Two good crops have been raised in the dredged district, and the third year, 1916, there was so much rain in the early spring and summer that the crops, or the greater portion of them, were drowned out. The ditch was not designed

to take care of extraordinary floods, and during the past year the water has gone out of the channel and covered the low-lands in the bottoms in some places. Notwithstanding these extraordinary floods, the ditch is now in fair condition; the upper end of the ditch has considerable sand in it, caused by some large branches emptying into it at this point; in the lower end of the ditch sand has accumulated in it, and the remainder or the middle section of the ditch is now in good condition and is as deep as when originally dredged.

In places where the main channel is cut very near the steep hills on the sides, in case of high floods, the water breaks over the channel at these points and runs across into the lower lands, causing damage to the banks of the channel, and leaves sand at these places of "break-over."

We have some wet land belonging to persons in the district who cannot drain their own lands in the main channel without crossing over lands of others, and in such cases the land is not benefited by the dredging.

All obstructions have been kept out of the channel by the commissioners. As much as seventy bushels of corn per acre has been raised on the dredged land in this district without fertilizer, and an enormous crop of corn was raised on the land in this district in 1915.

From the health standpoint, the dredging has been a remarkable success. Malaria and chills have decreased, so the doctors say, 75 per cent. From an agricultural standpoint, the drainage of this district has been a success, and the ditch has maintained itself as well as those who favored the project had hoped for in the beginning.

REPORTS ON DEVELOPMENT OF INDIVIDUAL DRAINAGE PROJECTS

NEWPORT NEWS, VA., October 17, 1916.

HON. JOSEPH HYDE PRATT,
North Carolina Drainage Association,
Chapel Hill, N. C.

DEAR SIR:—I appreciate very much your invitation to attend the Ninth Annual Convention of your Association in Greensboro in November, but fear there is little chance that I can be present.

In connection with drainage in general, I would like to invite your attention to a condition that seems to me to have the effect of discouraging large drainage projects, and one that should receive the consideration of the State authorities interested in agriculture, drainage, and colonization.

The Norfolk and Carolina Development Corporation owns about 4,000 acres of land in Perquimans County which has been drained by means of about ten miles of canals averaging about 20 feet in width, under the laws of your State, the cost having been covered by an issue of \$30,000 of drainage bonds. This land lies along the branch of the Norfolk and Southern Railroad which extends west from Elizabeth City, and other lands not owned by this company are also included in this district.

The drainage project has been completed and the land is dry and ready for settlement, but we have been unable to dispose of it, although we have offered portions of it at \$10 and \$12 per acre. It is understood that land in some of the other drainage districts is selling at \$50 and more per acre. The canals show soil of great depth and richness, and I believe this land will be very profitable to settlers. The low prices for which it is offered seem to me an

evidence of liberality on the part of the company that should dispel any idea that the company is seeking exorbitant profits.

It is possible that the company has not given its property as much publicity as it might, but it seems to me that the State agricultural and colonization authorities might investigate this property, and, if the soil and other natural conditions are as favorable as we believe they are, could induce settlers to take up some of this land, thus affording a valuable demonstration of the richness and productivity of your eastern lands that would be of great benefit to your State.

The drainage tax assessments per acre for ten years until the bonds are retired will be much less than the cost of fertilizer required for most agricultural lands.

It seems to me that the interests of the State require the same effort on the part of its authorities to insure the success of a drainage project by assistance in colonization after completion as are used to initiate the drainage project, and it would be deeply appreciated if you can see your way clear to bring this to the attention of the proper State authorities to the end that our property may be given a thorough investigation, followed by their coöperation in the development of it if the results of the investigation should warrant it.

Mr. R. Page Waller, 551 Warren Crescent, Norfolk, Va., is president of the company, has recently been over its property, and will be glad to communicate with any authorities you may suggest.

Thanking you for any suggestions or good offices you may extend in this matter, I am

Very truly yours,

(Signed) JAMES W. SIMS.

BAYBORO, N. C., October 31, 1916.

MR. JOSEPH HYDE PRATT, *Secretary-Treasurer,*
Chapel Hill, N. C.

DEAR SIR:—We have your announcement stating that the Ninth Annual Convention of North Carolina Drainage Association will be held at Greensboro, N. C., November 22 and 23, and the writer expects to attend this Convention.

I would like to state that we are developing in Eastern Carolina a section of country by a very unique method; in fact, we do not know of any other project which has been put through under similar conditions. We have several thousand acres of land in the counties of Pitt, Beaufort, and Craven, which we are draining for a portion of the land involved. As you no doubt know, there are thousands of acres of land in this section of the State considered worthless by the landowners, in its present state. In a great many instances they own large tracts of land which they do not care to put in a regular drainage district organized under laws of the State, and be taxed for the improvement, but they are willing to give a portion of this land which they own to some person, firm, or corporation who would be willing to go in and develop the property along these lines. The landowner figures that the land in its present condition being worthless, he has all to gain and nothing to lose by the proposition, and in this way thousands of acres can be reclaimed in Eastern Carolina, without the regularly organized district, it being simply

a question of getting capital with sufficient confidence in the future development of the section to take hold of the proposition.

After the completion of the original construction work, it would be a good idea to organize a drainage district for the future maintenance of the system.

Mr. C. G. Elliott of Washington, D. C., has been our consulting engineer on the proposition which we have undertaken, and Mr. Elliott pronounces it most unique.

We are getting along fine with same and have great confidence in future developments along these lines. I thought I would mention this to you, as I doubt whether or not you have ever heard of such a proposition being put through. We have over one hundred and fifty landowners involved in this drainage scheme.

Yours very truly,

(Signed) C. W. HODGES.

NORTH CAROLINA DRAINAGE LAW

By HON. JOHN H. SMALL, Congressman from the First District

Mr. President and Gentlemen: All I may hope to do during the brief hour I shall occupy your time this afternoon is to bring to you a few sheaves of thought gathered from a very busy life which may be applicable to the deliberations of this Convention. I do not think I can preface my remarks in any more appropriate way than by directing attention to the most interesting proceedings of this morning's Convention. Much is the pity that hundreds of farmers, landowners, and forward-looking men in North Carolina who are interested in this great subject of reclamation and conservation of the resources of land could not have been present to have heard the discussion. Not least interesting were the very appropriate and well expressed remarks of the President of the Association. I take great pleasure in referring to the remarks of the President, because he is a native of my own county and one of the progressive citizens of eastern North Carolina. His activities are not confined alone to words; he is the most efficient chairman of the Board of Drainage Commissioners of the Pantego Drainage District. He has taken an active interest in this great movement for drainage, and is probably as well acquainted with the details and workings of the present law and the amendments which are necessary as any citizen of the State.

I have been asked to say something regarding the proposed amendments to the drainage law, and I shall first speak about the law in its present shape. This law has worked well in North Carolina. It was the first instance where we attempted to translate into law and into works the spirit of coöperation in the drainage of our lands. Heretofore, as Mr. Camp said this morning, it has been the case of each individual landowner attempting alone the solution of the problem of land drainage, with the result that, except in isolated instances, there had been few illustrations of efficient drainage of land. This law recognizes the proposition that land drainage of necessity must be applicable to large areas owned by many individuals or corporations, and that they must unite in order to secure, first, the most economical drainage, and, second, the only means of securing efficient drainage. Many times references have been made to the law as being cumbersome and complex; and the criticism is true, and those who desire to amend the law by simplifying its provisions

and making it more plain to the laymen, and less difficult to follow by the average lawyer, have laid their criticisms well; but unfortunately it is probable that their desires cannot be entirely accomplished. This law is based on a fundamental proposition that some landowners have the right to impress their lands and the lands even of unwilling landowners with a public use or burden. We are one of the oldest States in the Union, and our statute law and the law as formulated by our Supreme Court during its entire history has tended to throw around the ownership of land and all other property every opportunity for the assertion of individual rights for the protection of their property; and this had to be kept in mind in the drafting of this original drainage law, in which I had the honor to take a leading part. The principle embodied in the law of our State, that whenever you attempt to put a burden upon the property of another, an opportunity must be given to the owner of that property at the different stages of the proceedings in which you are attempting to put the burden on it to come into court and make any objections to it which he thinks might be valid, and have these objections passed upon by a court of competent jurisdiction. If I have expressed myself clearly, it means this, that at any stage of a proceeding, where a financial burden or a public use of any kind is sought to be impressed upon the property of another, the owner of that property must have his day in court to assert what he thinks are his rights; so that in the drafting of this law it seemed necessary to recognize that principle so prominent in the law of North Carolina, and that is the reason for much of the prolixity and apparently numerous opportunities which are given to landowners to make objections and have these objections passed upon by the court; and in any amendment to this law that feature of our North Carolina law must be rigidly kept in mind. For instance, a drainage law applicable to one of the new States of the Union, like Ohio or Minnesota, or even Arkansas, would not be applicable to North Carolina, because those are new States coming into the Union long after North Carolina, one of the original States, with constitutions somewhat different. A law that would be valid in those States would stand in great danger of being declared invalid by the Supreme Court of our State, owing to the fundamental feature of the law of North Carolina regarding the rights of those who own property, when it is attempted to impress upon that property any burden or public use. There is this to be said about the present law, that with one exception all the attacks which have been made upon it have been unsuccessful, and it has been substantially sustained. The only exception lay in one provision which attempted to exempt from taxation the bonds of a district. That was inserted with grave doubts as to its validity, and it was this section that was afterwards declared invalid by the Supreme Court.

The law has wrought well in the economic welfare and progress of the State. I read in the *Greensboro Daily News* this morning a most interesting interview with Dr. Pratt, in which he stated that the operation of this law with districts which had already been fully established, and now in operation, and with districts which are in process of formation and about which there was no doubt as to their completion, that it will have added to the tangible wealth of the State at least the sum of fifty million dollars. In other words, it has added to the State that which can easily be capitalized by all the rules of finance, an increase in the wealth of North Carolina to the extent of that

large sum of money. Any law which has worked so well is certainly entitled to commendation.

There are, however, some amendments which experience has taught us are necessary. To recite these amendments in an informal address would be both impracticable and uninteresting, and I shall only attempt to mention one or two of them and leave to subsequent queries which may be propounded further discussion of details.

There is one defect in the law which is transparent. Tracts of land included originally in drainage districts have changed title by deed or by devolution upon the death of the owner or by involuntary devolution through foreclosure of mortgages; and very frequently these lands have been divided and are now owned by two or three, or sometimes a dozen different owners. There is no provision under the present law by which there may be a reassessment of a drainage tax so as to separate the tax upon the different parcels of land into which the original tract has been subdivided, so that it is left to agreement to make a division of the drainage tax among the new owners. Where all are disposed to be agreeable and fair and just, an agreement can be made; but very frequently that is impossible, with resultant confusion when it comes to the payment of the drainage tax. Under the present law the original owner, or at least the original land as a whole, is bound for the original drainage tax as imposed in the drainage proceedings.

Many have suggested that there ought to be a larger number of classes into which lands are divided, thereby varying the proportion of the drainage tax. That has been particularly observed in those large bodies of swamp lands in the east which have been reclaimed, surrounded as they frequently are by land reclaimed many years ago, and where the differences in the proportionate liability are so marked that the present number of classes (6) do not represent sufficient elasticity in order to cover all the proportions of liability, and it is believed that an increase to at least eight classes would be better in the administration of the law.

There is nothing in the present law which provides a length of term for the Drainage Commissioners. Their terms ought to be fixed, and there ought to be some method of compensation, particularly for the Chairman of the Board of Drainage Commissioners, with some per diem for the members of the board whenever it becomes essential for them to meet to transact the business of the district. The position of Chairman of the Board of Drainage Commissioners is an exceedingly important one. During the latter stages of the formation of a district his duties are numerous and responsible, and after the drainage district is established questions are constantly arising in the administration of the law. Questions of reassessment for the maintenance of the district arise, and that officer is the executive head of the district, corresponding to the president of a corporation, and ought to be a man of affairs, with administrative capacity, and he ought to be paid a reasonable compensation for his time and talent devoted to it.

I can see how dry this is by looking into your faces, and if I were going into further details, it would be even more stale and less entertaining than these provisions I have just submitted to you.

To be personal just a moment, I had promised myself, and had so expressed to Dr. Pratt and perhaps others, that I would endeavor to redraft our entire drainage law, and to that end I gathered the drainage laws of a number of

States last summer. I secured the drainage laws of Arkansas, of Missouri, of Wisconsin, of South Carolina, of Georgia, and of Louisiana, and I devoted all my nights for a week to studying these laws, and I became convinced that while it is a most desirable consummation to redraft our law, simplify it to as great an extent as possible, consistent with our own local conditions and laws in North Carolina, yet it would require at least some weeks of constant work to complete same. To illustrate, take a competent lawyer who may undertake to redraft the law. If he is a wise lawyer, he would include the best provisions in the laws of all the States, having regard for clearness and simplicity. He would then test the same by the Constitution and decisions of our State, to the end that it might be both workable and valid. I have expressed enough, I think, to convince you that it is quite a task, so that so far as I am concerned, with the demands upon my time between now and next March, I shall not be able to carry out the promise I made to myself; but I intend immediately to take all the suggestions submitted to me by Dr. Pratt with those sent in by others, and draft certain amendments to be submitted to our next Legislature, soon to convene, and Dr. Pratt will submit them to the Legislative Committee and to intelligent men throughout the State with a view to eliciting further suggestions. While this is somewhat personal, I simply express it for your information, and that you might know that progress is being made and that the plans in mind promise that these amendments will be ready to be submitted to the next Legislature.

Gentlemen, how may we promote the progress of this drainage movement in North Carolina? I listened sympathetically this morning to the remarks of gentlemen from different counties who spoke about their experiences. The gentleman from Sampson County, the very progressive gentleman from Forsyth County, and others who, in the face of efforts upon their part, perhaps with the coöperation of some other landowners, had yet failed to translate into reality their aspirations for the establishment of drainage districts in their respective localities. I ask, Why does that condition exist? I suspect that probably the primary cause is due to what Mr. Camp said this morning. We have cultivated for more than a century in North Carolina individuality, personal independence, and have neglected to inculcate into the minds and consciences of our people the necessity for coöperation. I was delighted to see in the meeting of the North Carolina Farmers' Union the other day in Raleigh, as reported by the press, this subject of coöperation stressed and emphasized, because in it lies the solution of so many of these pressing problems, in which are involved the welfare and progress of North Carolina. We cannot have churches without that spirit; we cannot press forward in this movement for building and maintaining better highways unless we have it; until this spirit was engrafted upon the consciences of the people of North Carolina we never had any public school system worthy of the name. It is only through that spirit of coöperation that thousands of rural and urban school districts in North Carolina have voluntarily levied upon themselves local taxes to supplement the general school fund to provide better school buildings, longer terms, better trained school teachers, and teachers at a living wage; and we will only solve this drainage problem when we have shown the landowners that drainage is not an individual burden, but a community burden. I think that constitutes the basic difficulty which these gentlemen have found in the establishment of drainage districts in their respective

sections. You cannot overturn the viewpoint of a people established by the teachings of a century by any immediate process. Just as it required time to create the erroneous thought, just so will it require time to remove it and substitute for it a more generous and profitable thought. Only by the educational process will we be able to bring about that condition of the public mind which will induce landowners to change their viewpoint and cooperate with other landowners in the establishment of drainage districts. To him to whom much has been given, much will be expected, and we to whom have been given not only native intelligence but education as well, and a cultivated mind, we who have been brought into the new atmosphere of light and knowledge, upon us is incumbent the duty of being leaders in these educational processes, which shall convert individuality into cooperative endeavor. I may refer to another handicap in the fact that some citizens substitute prejudice for intelligence. How many men do we find, when we seek to advance a cooperative activity, who express as their first thought upon the subject not the merits of the proposition, but the fact that they dislike some one connected with it, or that in some way something has occurred to arouse their prejudice! The most difficult combination against which progress has to fight are ignorance and prejudice; combine the two together and you have an obstacle which is nearly insurmountable. I doubt not that in the experience of these gentlemen who have spoken this morning, and in the experience of others of us who have attempted to be observant of these activities going forward in the State, that these constitute the chief difficulties. We must have the patience of Job, must emulate the wisdom of Solomon, and must have the persistence necessary in all good undertakings. I heard a man say in politics (I won't say to which political party he belonged) that the way to get a North Carolina electorate aroused was to appeal to their prejudice. I hope he was not telling the truth. The trouble was he thought he was speaking the truth. It ought not to be true either in government, which is only another name for politics, and we ought to enlist in the army of intelligence with the purpose of eradicating this prejudice and substituting for it the generous light of intelligence.

In conclusion, I would like to ask why so small an attendance at this meeting? May I express what to me is a doctrine which ought to inspire every citizen? I believe it is the solemn duty of every man and woman to select one or more public activities, more than one if possible, which are intended to promote the public welfare and to serve humanity, and to devote to these activities the best they have in time, in talent, and in means. I further believe that upon every citizen whom the people have made their public servant, whether they serve in the humblest or in the highest capacity, that it is doubly incumbent upon him to engage in the activities which make for the public welfare. I would like to see abroad among our citizenship in North Carolina an ideal of service of that kind, not only applicable to themselves, but applicable to every one of their public servants, whether they be municipal, county, State, or Federal.

Now here is an activity in an economic sense greater than any other. Here is an activity which directly adds to the wealth of North Carolina in the proportion with which we prosecute it. As a matter of fact, we provide public schools, and yet in doing so we know we provide for the next generation, and only by reflex upon our own. Here is something that affects all of North

Carolina; our level alluvial lands in the east, these rich bottoms in the Piedmont section, and in the mountains. There are hundreds of thousands of acres of land in this area which ought to be immune from damage by water, which might be drained, and will be when we properly appreciate its importance. Why are not the men from eastern North Carolina here? and I speak because it is my section. There are hundreds of men down there who have been the beneficiaries of this law and know its benefits. Why are they not here? They represent the type of citizen who does not care to bring to other North Carolinians the blessings which they have received. No matter where we may meet in North Carolina, we ought to have a large attendance of forward-looking men from every section of the State. I do not think there is any danger of the Association dying a premature death; I think there are men who will stand by it till the end, until its blessings are scattered throughout the entire length and breadth of our State. But we do not wish to wait indefinitely. We wish to hurry forward the day so that we shall enhance that reputation which we enjoy as being one of the forward States in the South as well as in the Union. Because we have been slothful in so many things, and indifferent so long to the utilization and the development of the great resources of our State, is no reason why we should continue in that condition, but with the present light and knowledge which we possess of the benefits which will accrue, we ought to impress upon ourselves and on others that zeal and love for service without which some of the greatest blessings cannot come to the people of the State.

Gentlemen, I was asked to talk to you on the Drainage Law, and instead of that I have occupied most of the time preaching. It may be that a little sermon of this kind, if it is righteous doctrine, will be of some encouragement and will hasten the day when we may enjoy the full fruition of this movement, and thereby greatly add to the wealth and progress of this good State.

DRAINAGE FINANCING

By BRUCE CRAVEN, Attorney-at-Law, Trinity, N. C.

It is generally believed that any discussion of finances is a dry subject, and therefore it would appear that the subject of Drainage Financing would be doubly dry, since the purpose of drainage is to make things dry; so you, in the generosity of your hearts, will have to bear with me in the presentation of a few plain, pertinent facts regarding a very vital element in this truly great work of turning the waste places into paradises of plenty and beauty.

It happens that in the practice of law, a very large portion of my time and attention is in connection with municipal bonds in North Carolina, and has been for some time. It is an open secret that drainage bonds, as issued in North Carolina, are the least desirable of all such securities, and for the good of the work throughout the State, some remedy for this should be found. Unfortunately there is not much business attention given to the financial end of a drainage project, and hence a good part of the money is thrown away. For one thing, there is usually a great effort to sell the bonds at a high-sounding price, and not enough attention is given to the more important point of getting the best and the cheapest contractor to do the work. There is little system about the whole business, and lack of system means direct loss in any enterprise.

The difficulty about the bonds is the low assessed valuation back of them. The ultimate investor in securities must know from the financial statement that his investment is not only safe but absolutely and unquestionably perfect. The usual basis of valuing securities is that the total bonded debt against any district should not exceed ten per cent of the assessed valuation; the usual drainage district as compared to this has a debt of anywhere from 25 per cent to 100 per cent of the assessed valuation. In the usual course of the bond business this class of securities cannot be handled.

The first remedy ever suggested was that the owners of the low-lands should include in the district their whole farms. This is impracticable for two reasons: first, it would be an unequal burden on the basis of the benefits of the drainage; and second, it would increase the opposition on the part of the few objectors who nearly always try to prevent the improvement.

A second suggestion is, that after the drainage district is formed the property inside of it should be re-assessed at a high valuation, so as to make the assessed value at least five times the amount of the debt. The objection to this is that the increased assessment would apply as well to all other taxes as to the drainage tax. For this reason this suggestion is impracticable.

There remains only two possible recourses, and these are two methods of one general idea, and it should have your most earnest consideration. The main idea is that the county assume the obligation of the debt. Let the drainage district be named numerically according to the county in which it is located. Model the bond provision after the State-wide road bond law, and have the bonds issued and sold and signed by the county commissioners, and the taxes levied and the interest and principal paid by the county commissioners. The county in this law can assume the guarantee of the debt, and this will result in making it a direct obligation of the county, and all the dealings on the part of the bondholder will be with the county, and he will have nothing to do with local district officials. The other method in the same general idea is for the county to take up the drainage bonds and issue direct county bonds in place of them, holding the drainage bonds as security. The first suggestion, however, is undoubtedly the better one.

What would be the result? It can best be told by comparison. I personally know an owner of land inside a drainage district who has money out at interest at 6 per cent. If he paid taxes on that money, his net income from it is about 5 per cent, together with the risk of loss and the annoyance of attending to a private loan. The same man as part of the drainage district is at the same time paying 8 per cent interest on the outstanding debt against the district, though the debt is a public one and safe and free from annoyance; and he is a good, common-sense business farmer.

The drainage bonds, on account of the very low assessed valuation, were sold at ninety cents on the dollar. They bear 6 per cent interest and average five years. The real interest, therefore, paid on the money actually received is 8 per cent, and the bonds are practically free from taxation. While not legally exempt from taxation, yet I would not like to depend for a living on the taxes paid on the millions and millions of dollars of such bonds now outstanding against different bond districts in North Carolina.

If the county in which my friend lives should do its full duty it would make my friend list his solvent credits at their full value and pay taxes on them, and then it would assume the obligation of the drainage bonds and take the re-

sponsibility, which it could do without any possibility of loss. The result would be a benefit to every one concerned, even to the county itself. The drainage district would be the most benefited, because it would sell those same 6 per cent bonds at a good premium, and thus add about 15 per cent to the amount of actual work done for the same money, and no one would lose anything. This is what I call business methods in public office, and it is a method that should prevail everywhere.

Two ideas have been advanced along this line that are plainly erroneous. One is that the drainage project cannot be aided by the county because of its being in the nature of a private enterprise. Among lawyers, at least, that idea is too far afield even for discussion, as there simply isn't any doubt at all about drainage bonds being public just as much as any other bonds; and the county or the State can guarantee any or all of them if it will, and I have yet to hear of any reason why it should not do so. The other erroneous idea is that the situation could be helped by making the bonds redeemable at any time at the convenience of the district. This not only would *not* help, but would further deprecate the value of the bonds. The term of years as it is is very short for a security which is bought as a permanent investment, and the suggested change would make them considered as one-year bonds, as they could be taken up that way if desired. The term of years as now prescribed is short enough, and if the bonds could be guaranteed by the county as advocated, it would still further add to the value to increase the term to fifteen years or even twenty. However, this should not be done without the guarantee by the county.

It has been well said and often said that "the shoemaker should stick to his last," and it is well to remember this in connection with revising or amending any law. It should be done only by those who know what they are doing, and what they want to do, and how to do it. The drainage law should be handled by men who know the drainage law. A careful comparison of the North Carolina law with those of other States convinces me that our law is the best working law of them all. Perhaps it needs some changes, but it is better to leave it as it is than to have amendments tacked on to it by a legislator who knows nothing of the law except the one little hobby that happens to be in his mind.

The drainage work, as represented in this Association, is a great and useful work. It is true work, because it is creative. It is making new wealth in our State, and therefore benefiting all the people. The whole people should be interested in any movement that tends to produce wealth, and the new generation in North Carolina will look for leadership to the leaders who stand upon these principles and really lead the fight for better economic conditions for the whole State and the whole people.

DISCUSSION OF NORTH CAROLINA DRAINAGE LAW

DR. PRATT: I am not going to try to make many suggestions in regard to the amendments or changes to the North Carolina Drainage Law. I want to go back a little bit, to 1909, when the drainage law was passed, and answer to a certain extent certain questions that were raised by Mr. Small. I am going to ask a question myself, and then answer it. How

was the drainage law passed in 1909? If you could take the drainage law as we published it after the General Assembly of 1909 adjourned, you would find that there was not a single change in any section of that law from the time that it was introduced until it was passed and ratified by the General Assembly of 1909. Not a single amendment was made to any section of the original law as it was introduced into the General Assembly of 1909. How was that done? It was because the North Carolina Drainage Association got back of that law, went to Raleigh, not only three or four men (as Mr. Small said, three or four men stayed there all the time) at the hearings before the Committee of the House, but there were at least twenty or twenty-five members of the North Carolina Drainage Association to back up the bill after it had been introduced. Our chief fight came in the House. As I remember it, there were twenty-nine amendments suggested to that bill, and each one of them was voted down. When they finally got to the ninth or tenth amendment it got to be a laughing matter. It was because this Association realized the value and need of that drainage law, and the Legislative Committee of this Association, composed of some of the very best lawyers in North Carolina who were interested in North Carolina and in drainage work, spent months and months drafting and redrafting that drainage law, to make it, as far as they could, the most effective drainage law that could be obtained for the State of North Carolina. Representing your Association, they went before the General Assembly of 1909 and told them through your committee that they did not believe it was possible for the General Assembly of North Carolina to give to this bill more thought in the sixty days they were there than these people had given to it in months of work. So it was passed as it was presented. We were able to convince the committee of the House that that law was in the interest of the people in the drainage sections of the State, and that they wanted and needed it as it stood. In 1911 we passed a few amendments. Certain ones were suggested, but we did not have the same backing of the Association as in 1909. The Association felt that the drainage work would take care of itself, because already the drainage law was passed. But what I have been working for ever since is to get this Association in such standing throughout North Carolina as to make the people and legislators realize that what they demand passed as amendments to this drainage law are for the best interests of the drainage work in the State. It is just as bad for the North Carolina Drainage Law to be amended without our suggestions as it is not to pass the amendments that we recommend, and I believe if you could put back of this Association the same force and determination that we had in 1909, we could convince any General Assembly that this Association

knows what is needed in regard to amendments to the North Carolina Drainage Law. I mean the State Drainage Law; we have nothing to do with the local drainage laws. There are two or three members of the General Assembly of 1915 here today, one from Robeson and one from Durham County, who were in the House. They will probably remember that we had drawn up through our Legislative Committee certain amendments to be presented to this Legislature. They were introduced into the House, went before the Drainage Committee, and, if I remember correctly, there were several on that Drainage Committee who were anything but favorable to the drainage work in North Carolina, and that committee began at once to try to pick to pieces and amend and change the proposed amendments of this Association, and it looked as though nothing would go through as proposed by the Association. It was finally thought best not to try to pass anything rather than to pass the amendments that were being proposed by the committee of the Legislature. The point I want to bring out is this: that if we had had last year, before the Legislature of 1915, the same backing and determination to have our amendments passed as we had in 1909, when the drainage law itself was passed, they would have been passed, because we could have gone before the committee and impressed them with the necessity for this law and the strength of its backing. There was one amendment that passed which was not recommended by the Association. This amendment was introduced, and by the time it came out and was ratified, instead of doing as it was supposed to do and amend section 11, it repealed section 2. That was taken up to the Supreme Court, and it was decided that without question section 11 was the one to be repealed.

The point I want to bring out is that if we are going, as an Association, to try to have the influence that we ought to have in framing legislation regarding the North Carolina Drainage Law, we have got to get together in larger numbers than we are here today. We have got to go to Raleigh and work for these proposed amendments.

MR. THOMPSON: Whatever we decide on, it is very hard to get it enacted into law. Before we adjourn I hope we will have some concrete plan presented that will insure a large attendance over at Raleigh.

MR. JOHNSON: I am frank to say that the gentleman who preceded me could have said all I know to say about this drainage law. I can only emphasize some of the points that have already been mentioned by telling about the actual application to our district. The most vital objection to our law as it stands now is the lack of any provision for releasing the land that has been sold. I will mention one instance. In our district we have one tract of land which is put down to a man named Luther Lynn, and there are now sixteen different people who own an

interest in that land. Last year Mr. Lynn went to the sheriff to pay his taxes, and he was told that he had 90 acres on which to pay tax. The sheriff was compelled to say, "I cannot release you from the payment of this small sum, because the payment is so much and is based on 90 acres of land." I own an interest in this land, and I offered to pay my part to the sheriff, and in looking over his books he found I had no interest whatever, and therefore he refused to give me a receipt. A number of others did likewise; and to this day the matter is unsettled, and it looks as if we will have litigation in the end, because the whole tract was sold to settle this one small claim. It is my idea that once a year prior to the time when the sheriff collects these drainage taxes, that the books shall either be remade entirely or revised in such a manner that the present owner of each tract of land shall be stated on that book, always keeping in mind the revenues of the whole number of acres and the total tax in accordance with the bonds already issued. It is my opinion that the chairman of the drainage district is the one with whom this change should be registered; but it does not matter who does it; somebody should be designated to make this change.

In connection with this revision of the law, there is another point which has not been mentioned. You know that one type of land may be assessed in five different classes. Now, there is no physical marking on the drainage map to show these different classes, and there is no reference in the tax assessments to the different classes under which one body of land is placed; that is, which part is Class A and which part is Class E. Naturally, a man who has bought land out of a tract having these various classifications wants to believe that he has bought the lowest class land, and it is absolutely essential that some one have charge of this work and know into what class this land is placed. There should be some physical mark on the map showing exactly where these classes are located. It would be more expensive to do this, and will take more engineering, but I am satisfied that in the end it will give more satisfaction.

The election of commissioners is provided for, but as Mr. Small has well said, there is no term of office fixed, there is no provision by which a commissioner can resign, be removed, or, in case he quits anyhow, another be elected. I believe their term of office should expire at some definite time, and provision be made for others to be elected. As to the compensation for the commissioners, we cannot, I believe, fix a compensation for all the districts, because the chairman of some district may have a great deal more work to do than others; but, generally speaking, the chairman is the man who has the most to do, and is the one who should be paid. I believe if the commissioners were

paid for their work they would take more interest in the work than they do now. You see, as the matter stands now, the commissioners have to serve whether they would or not, and are not allowed any compensation for the time spent on this work. They take this attitude, "You people got us into this thing; you ought to get us out."

I want to say that I would have been willing to come all the way to Greensboro to hear the fine words Mr. Small said about me, because I have had to contend with everything except lynching in connection with the drainage work in our section. It gives me great pleasure to say, however, that barring this one trouble in the listing of taxes, almost every person in our three districts has become reconciled, and I believe that if the question were put today there would not be three persons who would eliminate the whole thing and go back to where we were three years ago.

I have attended several sessions of the Legislature, and have been a member a number of times of a Drainage Committee, and I do not think that our lawmakers are antagonistic to our drainage law; but they do not understand it, and we have not taken the trouble we should to educate them. I believe it is our duty to educate our lawmakers, to show them the value of this drainage law, and to show them the necessity for certain amendments which we think are necessary to make the law more effective; and so I think this Legislative Committee of our Association must take the time to properly formulate these amendments that we need, and properly present them to the Legislature.

MR. FULLERTON, representing Tilotson & Wolcott Company, Cleveland, Ohio: I do not know that I can add much to what has been said. I agree thoroughly with Mr. Craven in regard to what he says about the bonds and the profits that the bond dealers have to make as distributed over a period of years. In regard to making the bonds more salable, his idea of making them county obligations would be very good if it can be carried out. I think there would be a good deal of opposition to this in the counties. It would make the bonds more salable, however. It is done in Florida and Tennessee. They are not exactly county obligations, but they are signed by county officials, who guarantee the collections, and they are levied the same as other taxes, by the same officials. These bonds are better thought of than the bonds which are put out by the commissioners. That is, have the county officials sign the bonds and take care of the collections. In that way I think it is a matter that could be gotten through with the people. I think you have a very good law as it stands. Of course, if you were to include the uplands, it would increase the value of the bonds; but I believe it would be almost impossible to do that.

MR. THOMPSON: We have found that if we tie up some of the other land in the bond, that is, some of the land adjacent to the creek bottoms, that we have a better bond because of it.

In connection with the point Dr. Pratt brought out, about bringing matters before the Legislature in a favorable way, it is suggested that we might have a midwinter meeting in Raleigh. I believe if we could get a meeting of the Association at that time, we would be able to get what amendments we wanted put through, and I believe that we ought to give Dr. Pratt more support.

MR. SMALL: I think every suggestion seriously made ought to be seriously considered. I was very much impressed by the suggestion of Mr. Craven, supplemented by the suggestions of Mr. Fullerton. The point made by Mr. Craven that the solvency of the bonds would be very greatly increased if made the obligation of the county is unquestionably correct; but the only trouble is in giving it this obligation. I will point out one or two defects.

My observation has been that frequently in the legal proceedings for the establishment of districts the lawyer representing the district has not been careful to observe all the requirements of the law, the result being that when a certified copy is made of the record and sent to the attorney of the proposed purchaser of the bonds, usually some banking house, it is referred to some attorney who has made a specialty of the study of not only drainage, but all other classes of municipal bonds, or sub-agencies of the State. He has full knowledge of the law, having it before him, and having studied it with a critical and trained eye, he observes whether the law has been literally complied with, and if it has not been in all respects, he will make a note of it, and ordinarily will pass unfavorably upon the bonds because the law has not been literally observed. I have even observed instances of this kind, where the local attorney representing the district had failed to observe, or the record had failed to disclose, that a certain direction of the law had been observed. The local attorney had said that according to some decision of the Supreme Court of North Carolina it is presumed to be done. A bond attorney is not content with that; he wants the record to say that the law has literally been observed. Now, coming to my point: If in this way a drainage district is established, bonds are issued, and the bonds are turned over by provision of law to the county treasurer to collect, and the county issues its bonds, say at 5 per cent in lieu of the 6 per cent bonds of the drainage district, the county getting that profit of 1 per cent for its assumption of the liability, this condition would probably result, that the county would not have been as careful in examination of the law to see that the latter has been complied with as

this trained attorney, and it may be that there would be such a serious difficulty in the establishment of that district as to impair the validity of the bond of the drainage district. Now, if the county attorney would be as critical in his examination of the records as the bond attorney, he would be charged with being over-critical, fault would be found with him, and he would have a very difficult task before him. If, on the other hand, the record was not critically observed, and some vital defect overlooked, and there should be a default in the payment of any drainage taxes, and the county should institute proceedings to compel the payment of the drainage taxes, you could not rely upon the fact that because this was being done by the county, some landowner would not take advantage of that defect. He would go to some smart lawyer who would tell him that the validity of the bond issue could be successfully combated, and there might be an instance where the county would be liable for its own bonds, and yet not be able to indemnify itself for this expenditure out of the bonds of the district. If we had some method by which the same critical knowledge and trained study of the record of the district could be made as at present by some of these trained attorneys in the cities, the situation would be different.

I have just put a practical defect before you, which I am sure Mr. Craven will appreciate as well as any of you; so that it may be we will have to adopt the suggestion made by Mr. Fullerton: that is, have the bonds issued or rather assigned by the officials of the county, and then, as he says, an assessment collected by the officials of the county, to be turned over to the bond dealers, and, as suggested, the taxes collected by the same official who collects the State taxes; the treasurer of the county would be *ex officio* treasurer for the district. This seems to me about as far as we could safely go at this time, and we would have to change the law so that the bonds could be assigned to the county commissioners.

MR. ALEXANDER: There is one point right along where Mr. Small was talking. In organizing a district in Forsyth County, I suggested to them to let the county stand behind the bonds to make them more salable. They framed a bill at the last Legislature, and started to introduce it, and were scared off in some way. They were told that something conflicted with the Constitution of the State; that it was not constitutional for a county to stand for a private enterprise. If that be the case, it would not be possible to do this.

MR. SMALL: I think the formation of a drainage district implies subjecting private property to public use sufficient to take drainage bonds out of the class of private enterprise.

MR. ALEXANDER: Another point is about bringing in hill land. A good many districts in the Piedmont section, which have gone as much

as a half-mile from the edge of the bottom-land, take in the hill-land for the benefit to the bonds. We think that land is benefited from the standpoint of health. In other districts we have gone a half-mile from the stream, and in others we take an acre of hill-land for each two or three acres of bottom-land, so that it will not work a hardship. We have an understanding that that is to make the bonds more salable. It does not cost the individual any more, but we put the land in to guarantee the bonds. A case has been carried to the Supreme Court in Georgia where an equal acreage was taken in.

MR. SMALL: The highlands adjacent to the lowlands? The man who owns the highlands is in a position where the water must flow from his land to the lowland. He is known as the dominant owner, and the man in the lowland is the servient owner. Is there any right in law for the man above to put his water through the bottom-land in order to reach the common exit, without paying compensation? In other words, is not the owner of the bottom-land entitled to some rights in the matter? [There followed a discussion among several as to the relative legal rights or moral rights of the dominant and servient owners of land, which was not taken down.]

THURSDAY, NOVEMBER 23—Morning Session

The meeting was called to order by the President, Mr. P. H. Johnson.

MR. JOHNSON: I notice several representatives of railroads present, and I am sure we will be glad to hear from some of them. I take pleasure in presenting Mr. E. E. Hunter of the Seaboard Air Line Railway.

MR. HUNTER: *Mr. Chairman and Gentlemen of the Convention:* I want to make the statement that this is the first attempt I have ever made to speak in public, and when I presented my credentials I stated that I hoped I would not be called upon. Our people, of course, are vitally interested in this drainage question. Our President and Vice President express their regrets that they are not able to be here in person. We have recently organized a Land and Industrial Department, which is especially interested in the drainage question, and wants to take a much more active part than ever before. Recently our President went to Wilmington, and I rode back with him as far as Hamlet; passing back from Wilmington to Lumberton, he asked me why the country had not been developed. I told him that I could answer his question in one word, and that is drainage. Our newly appointed Developing Agent, Mr. Hamner, has also had considerable correspondence with me relative to this drainage development. I am confident that under his direction the Seaboard will take a much more active part in drainage

work than ever before, because we appreciate now that this is a vital question to the railroads, as well as the landowners of the State.

MR. JOHNSON: Dr. Pratt very kindly called my attention to the fact that we have another representative of a railroad here. I am indeed glad that the Southern Railway has manifested sufficient interest in this work to send a representative. I cannot, for the life of me, see why any railroad which penetrates any section of country where drainage is so essential as it is in most of eastern North Carolina—I say I cannot see why they should not regard the fostering of this drainage work as one of their greatest achievements.

As I stated, the Southern Railway has a representative here, and it is with great pleasure that I present Mr. Williams, who represents Mr. Harrison of that road.

MR. WILLIAMS: *Mr. President and Gentlemen:* As I told Dr. Pratt when I came here yesterday morning, drainage is something I know very little about, and I have been here listening and learning, and I have found the proceedings very instructive. I do not know that I can say much more. I cannot say anything that would enlighten you who are experienced in the subject, but I just want to say that I am very glad to have been here, and, as you all know, the Southern Railway Company is vitally interested in everything that tends to develop the territory which it traverses. It is in a way a selfish interest, because the business that the company depends upon comes from the development of the territory, but the benefits come first to the people who live in the territory and afterwards to the railroads, in the way of increased traffic. I will say again that I am very glad to have been here, and wish the Drainage Association of North Carolina every success. I would say that the agents of our company are working for farm development in the South, and reports show that they are advising people on that subject, especially in the matter of tile drainage in the drainage of individual farms.

MR. JOHNSON: The object of this Association is not so much to promote the drainage of the individual farms; the primary object of the Convention is to promote an interest in the general drainage of the whole State. About seven or eight years ago I was persuaded to sow some rye in my cotton when I laid it by; the next year I was persuaded to sow some in my hay patches when I cut my pea-vine hay. I just sowed a little, and it did so well that the next year I sowed a great deal more. I saw the success that some one else had attained in this, and I wanted to try it. It is the same way in carrying out the schemes for drainage, and especially for tile drainage. If one man tries it and is successful, then others will see his success, and are apt to take it up.

This Association had been so successful in draining swamp lands that last year we decided to attach another feature to our drainage work. In pursuance of this plan, we elected in Belhaven a Vice President whose duty it was to take charge of this work, and I refer to tile drainage. Even in our swamp-land districts it is becoming more and more apparent that open ditches, that is, lateral ditches, are costly and useless, and it is the purpose of this Association in the future to endeavor to promote an interest throughout the State in tile drainage, and we were fortunate in securing for our Vice President a gentleman who has had large experience in this particular kind of work, and his knowledge of this work is so far superior to mine that I feel it would be superfluous for me to do anything further than to present him, and let him take charge of the Convention this morning. I now take pleasure in presenting Professor M. E. Sherwin, who will preside over this meeting and present the tile drainage work.

GENERAL DISCUSSION RELATING TO DRAINAGE WORK

PROFESSOR M. E. SHERWIN presiding

PROFESSOR SHERWIN: Gentlemen, I am going to forego any maiden Vice Presidential speech—for the good of the whole Association. I want to say a word, though, about the relation of tile drainage, as I see it, to the work of the Association. I had no connection with the Association at the time it was started. In fact, I believe I was not in the State at the time it was started; but when the Association was organized I think the motto taken read: "To promote the drainage of swamp and overflowed lands." Now, that word "drainage" is a broad word, and can have many applications. It should not be limited to district drainage; but in the beginning of the Association the work was necessarily for the drainage of large areas, so that in North Carolina in many sections district drainage necessarily preceded tile drainage. In other words, it was impossible to tile drain, or, as we will say, completely drain individual farms until these larger drainage projects had been fully completed. I do not wish to interfere with the district drainage work, but the time has come when the tile drainage work should take and will take a much more important place as a State-wide movement and as a phase of interest to the Association. I consider that tile drainage is the final drainage of the land, that it necessarily follows district drainage in any section where district drainage is needed. There are sections that require district drainage where tile drainage is important, and probably in every section where drainage is needed tile drainage is needed to complete it, to put, as it were, the final capstone to the drainage work of the State. I hope we will see a great development in tile drainage in this

State, and I hope that this Association will be responsible for the success of this movement, and finally, when the land is drained, that this Association will get the credit, which it will then deserve, for the important work which it has undertaken.

Our program this morning will be very slightly changed from that as printed. The first number on the printed sheet, "Financing of Drainage in Relation to Federal Farm Loan Banks," was discussed by Mr. Camp yesterday morning. His associate in that work, who was also on the program, Mr. Culbreth, is not here; so we will consider that that number was completed in the yesterday morning session. In that connection I would like to call attention very briefly to the Ontario Drainage Law. The Province of Ontario several years ago provided means by which the individual farmers could drain their lands, which is equal in every respect to the Federal Farm Loan Act which was recently enacted by Congress. The point I wish to mention in this regard is the fact that in Ontario the loans run a long time, with privilege of payment at any time, and the actual cost, according to my recollection, is seven dollars and some cents annually for twenty years on each hundred dollars borrowed, making an interest rate, if you figure it down to the interest rate basis, of slightly over 4 per cent. That is probably as good an interest rate as we will ever get under our Federal Farm Loan Act.

Another change in the program will be the moving up of the subject of "Erosion," and this will be the first number on our program this morning. This subject is one of very great importance, as I doubt not the paper will bring out. This paper is by Mr. F. R. Baker of the North Carolina Department of Agriculture.

EROSION AND ITS PREVENTION

(Terracing)

By F. R. BAKER, Drainage Engineer

INTRODUCTION

Ladies and Gentlemen, Members of the North Carolina Drainage Association: The history of our Association is one of progress, adding new subjects from time to time, and I hope to see in the near future departments established to represent the various detail subjects relating to drainage, such as *standard specifications, construction and maintenance, financing, publicity*, etc. Last year we introduced the subject of tile drainage. I am now presenting a new subject, one in which the engineer and farmer have to coöperate in order to produce the best results.

Doubtless, the subject of erosion has not been seriously enough entertained by the engineer; yet much money is expended each year by governments and many engineers are employed to control problems whose existence can be traced to erosion.

Erosion is very active on the hill soils of the South, especially in North Carolina, South Carolina, Georgia, Alabama, Tennessee, and Missouri. Here the soils are generally of a sandy loam, clayey loam, or a sandy-clay nature, underlaid at a depth of 3 or 4 inches by either a stiff red, yellow, or blue clay that is impervious to water.

They are low in humus and are of a fine-grained texture. This together with the rolling nature of the slopes causes these lands to be very susceptible to erosion. In this way the amount of material removed each year is enormous. Probably the rivers of the United States carry over 100,000,000 tons of material each year. It is estimated that during a flood in the James River with a 10-foot crest 300,000 cubic yards of material was carried away in twenty-four hours. Even the rivers of North Carolina carry away some 4,000,000 tons of soil, resulting in a loss of over \$2,000,000 annually to the State.

It should be remembered that while this great amount of soil begins to accumulate on the individual farm, yet it is transported to distant places and deposited, thus involving a study not alone confined to the individual farmer. Hence this problem embodies three features of importance: a national, an engineering, and an agricultural.

ITS NATIONAL FEATURE

While its effects produce a serious national problem, yet the Government at present has very little to do with the control over the causes. Large amounts are expended annually in removing from our streams, reservoirs, and harbors sediment brought down by the rivers. A part of the silt and sand fills the smaller streams and destroys the valley lands. This reduces the run-off and carrying capacity of the streams and is directly the cause of floods that are becoming more frequent and a menace to the safety of our people.

In navigable streams the deposition of silt causes a filling or shifting of the channel and the formation of bars, and navigation becomes hazardous. In some places it is practically impossible to maintain reservoirs, the capacity of which are so reduced that only the flow of the rivers are available for water-power.

In almost every harbor the Government is maintaining dredges that are working incessantly to keep the channels open, little thinking why they have to do it. So it is clearly seen that erosion is truly a national problem, and the State and National governments should lend their energies in promoting methods of prevention and make laws, if necessary, to prohibit indiscreet and careless farming and deforestation.

THE ENGINEERING FEATURE

This then leads to a study of the principles involved in the rate of run-off, transporting power of running water, etc., which can only be intelligently investigated by one grounded in mathematics, experienced in gathering hydraulic data, and competent in deducting plans and formulæ from the data obtained. Clearly, it needs no argument to show the value of an engineer in preparing plans and estimates for building reservoirs, for devising means for keeping them open, for establishing data on hydraulics, and for supervising the operation of dredges in rivers and harbors; yet how often has the

engineer been called upon to experiment with the prevention of erosion, one of the chief causes of most of the trouble?

For many years this problem has been handled exclusively by the farmer, and the results show clearly the need of engineering advice.

What is needed, therefore, is an investigation of the flow of the water from the hillsides, with its control in view, and methods of preventing the movement of silt. It can be clearly seen that erosion is primarily due to the uncontrolled movement of water over an unprotected surface, coupled with the inability of the soil to properly absorb this water. Therefore, anything done to block this movement and promote absorption will lessen erosion. There are many ways of promoting absorption of the soils. Growing cover crops, turning under vegetation and humus, and practicing better methods of cultivation are perhaps the most popular; yet this in itself cannot prevent erosion in climates of heavy precipitation. Something is needed to check the run-off and distribute the flow so that the particles of soil will not be disturbed. Investigations have shown that this can be intelligently done by means of terraces, judiciously designed, to meet local conditions. They are entirely practical and can be used upon the washed lands on any farm and are within the means of the smallest farm operator. They have probably done more in certain sections to better farming conditions than any other single operation, even though their designs have been one of judicious averaging. Its engineering feature has lately been recognized, however, by engineers, and the Office of Public Roads and Rural Engineering has had a drainage engineer working upon this problem who has devised formulæ for their design. These formulæ treat of their cross-section, slope, vertical distance apart and length. With these formulæ properly applied and the terraces properly constructed, the erosion of the hill soils should cease, the migration of soils limited, the discharge into streams governed and made uniform, floods reduced to a minimum, and the need for dredging decreased.

ITS AGRICULTURAL FEATURE

(The Terrace)

Above all, however, ability is needed to properly work out these designs in the field. This, then, introduces an agricultural phase of the subject which includes the construction and methods of cropping.

Terracing is by no means a new subject, because it has been practiced for years in foreign countries. Even in China the preservation of the soils on hill and mountain slopes has only been effected by the use of the terrace.

There are many kinds of terraces in use, but only one that can be adapted to a wide range of conditions will be discussed here. This terrace was originally known as the "Mangum Terrace," but has since developed into the Broad Level and Broad Falling Terraces. Their constructions are the same, but in one case no outlet is provided as is done in the other. The principle of the Falling Terrace is to conduct the water away in a thin sheet with a small velocity, thus lessening its erosive effect and permitting the greater amount of the soil and fertilizers to remain. It is simply constructed but permanent in character, and is adapted to most slopes of less than 15 feet rise in 100 feet.

THE CONSTRUCTION

The construction of this terrace is a feature that determines its efficiency and upon which rests its future popularity.

The mistake heretofore made was to rely upon the eye for location and the plow alone for construction, and the result has been an incomplete, poorly constructed terrace, defeating the purpose for which they were intended. On the other hand, one must equip himself with a simple farm level, a two-horse plow, and a terrace drag.

The outlet where the water from the terraces is to discharge should first be selected. This can be a ditch on the side of the field, a depression, or a body of woods. The terraces should then be staked off with the level by placing small stakes or straws every 25 or 50 feet along the line, allowing a fall, as previously determined, which will not be over 6 inches to each 100 feet toward the outlet. The vertical distance between terraces is governed mainly by the sloping character of the land. This can be accurately determined by applying the formulæ devised. In general, however, it may be said that land with a slope as great as 6 feet in 100 would require a vertical spacing of 4 feet, while where the slope is as great as 15 feet, 5 feet will be required. The length of the terrace is governed by the available outlets, but it is bad practice to make one over 1,200 feet long.

With all the lines thus staked off, begin at the top of the hill with the large plow and follow each line, making all curves easy, and with this furrow as a center line, throw up a back-furrow strip about 10 feet wide. The last furrow should be plowed deep, which will allow better control of the drag. The drag is now run around on the lower and upper sides twice, letting the *hinged* portion follow loosely behind. It is then used with the hinged portion in place. In most soils it may be necessary for the driver to stand on the drag and by moving forward or backward the cutting power can be regulated. At times the tendency of the drag is to cut into the terrace instead of riding it at an angle. This can be regulated by fastening a rope to the end of the hinged portion, which when pulled will lift the drag.

After the terrace has settled it must be plowed again, beginning at the center and adding two or three furrows, as that will be 14 or 16 feet wide, which is wide enough the first year. The drag is then used again as described above, and should always be used after the terrace has been plowed.

If the above operation is done correctly there will be no loss in planting space, no banks to harbor weeds, and the use of the modern labor-saving machinery will be permitted. There will be little loss of fertilizers and soil and needed moisture. The fields will also be made larger and less irregular and the rows can be run in a direction to the best advantage. All of this can be secured at a cost of about 50 cents an acre.

CROPPING TERRACE LAND

Even with a good system of terraces much attention must be given to the methods of cultivation, as the former methods of farming have been closely allied with the causes of erosion. Cotton and corn have met the farming conditions in the South best, due to economic conditions and labor problems.

It has often happened that some land was cropped year after year to these two crops until the soil became so unproductive that its cultivation became

unprofitable. In this way the soil became exhausted of organic matter, and consequently the rains had little trouble in washing large gullies over the surface. This encouraged the cultivation of small areas here and there. Since the introduction of modern methods of cultivation with labor-saving machinery, however, the sentiment has changed in favor of the cultivation of larger areas, as the future use of labor-saving machinery is more or less dependent upon the cultivation of the lands in larger and less irregular bodies. The use of the broad terrace makes this practice possible.

During the first year of cultivation the rows should not cross the terraces, but run practically parallel to them, and the terraces may be utilized by planting them to peas, clovers, oats, or such similar crops. This will not only give revenue, but will give strength to the terraces and keep them from breaking.

The above system of plowing, however, will necessitate short rows. One has stated that it is best to work in two short rows occasionally before finishing, in order to prevent having all the short rows running out together, which would cause too great an accumulation of water at one point. This is the most inconvenient farming operation in connection with the terrace, yet the redeeming feature is that it only lasts during a period of one year. As soon as the terraces have become permanent, the land can be cultivated in any manner most convenient to the owner and the rows run in any direction best suited to local conditions. Yet the usual care should be exercised in crossing a terrace. The plow must be lifted slightly and the furrows filled so that a waterway cannot be started.

Even though the broad terrace can be used under a wide range of conditions, yet the question of adapting crop rotations should be considered before planning terrace systems. It should be remembered that the incorporation of large quantities of organic matter produces an open, porous soil capable of absorbing water, and that deep plowing furnishes a reservoir for the storage of surplus water. This practice to a certain extent should always follow terracing, as terracing alone cannot restore fertility. Yet it is not always best to practice such methods on all crops, so that the tendency to erosion and effects of certain crops must be governing factors in terrace designs. For example, a certain Experiment Station has conducted experiments which indicate that plowing below 8 inches lessens the yield of cotton, and that the quality of tobacco is injured by legume humus, and large quantities of which will tend to produce weedy cotton. When such is the case, sufficient terraces should be incorporated to offset the lack of the above-mentioned practices.

RESULTS

The results from the use of the terrace are becoming general, and can now be seen on almost every farm in Piedmont North Carolina. In no case has there been a dissenting voice in instances where they have been properly used.

One small farmer without any capital came into possession of a worn-out farm. He at first became discouraged to find the gullies getting larger and the land getting poorer generally. He applied for aid, and we gave him a plan that he could follow from time to time. This was two years ago. Not long ago the writer had occasion to visit this farm again, and very little trace of erosion could be found on the sections that had been worked upon. This farmer is now reducing with ease a large mortgage on his farm.

At the State A. and E. College farm at West Raleigh, N. C., there was an eroded field with a gully 6 feet or more deep; but with the aid of terraces this field was made to yield results equal to those on any other portion of the farm. The same is true on all farms where the terrace is introduced. Its advantageous use is recognized as applicable over a wide range of conditions and over a wide territory.

This terrace was introduced about one year ago in Missouri, and reports that have recently come in tell of its successful operation and of its widespread popularity. In that time it has spread from one county to five, and is looked upon as the long-looked-for operation in the development of the washed soils of that State.

Land is one of our indispensable natural resources. It cannot be exhausted like some natural resources, yet it can be so depleted that its usefulness is destroyed. Its continual usefulness is of vital importance to our growing population, and the results of the action of natural and human agencies will determine whether land can be continuously used advantageously for man's purposes or not.

For three centuries slopes not protected have been destroyed, and the natural question is, How will our slopes look after three centuries more of corn and cotton culture?

Public sentiment should, therefore, be awakened to the seriousness of the problem, and the landowner brought to realize the importance of the increasing efforts of control.

Dr. Pratt makes an announcement in regard to an automobile ride for the delegates over the Guilford County roads, also of a visit to the plant of the Pomona Terra-Cotta Company, where tile drain is being made.

PROFESSOR SHERWIN: This country inherited tile drainage probably from England. England was the first country in the world to use farm tile drainage, except probably France. France is credited with having started tile drainage before England, but started it and forgot the art, and therefore does not get credit for it. We have with us this morning an Englishman thoroughly familiar with tile drainage in England and in this country. He is engaged in installing tile drains now. We will be glad to hear from Mr. Harry Cowley on the History of Tile Drainage.

MR. COWLEY: I was called upon by Dr. Pratt to give a little history of tile drainage in England. Of course, this is the first time I have ever been called upon to make a speech. I have been interested in this work ever since I was a boy. When I was a boy, about twelve years, I remember seeing my father drain with a plow drawn by four or six horses. The plow had a share in the shape of a torpedo. They had to dig a main drain along the bottom, and it was made up of brick and slate; roofing slates were fixed on the bottom, bricks put down upon the edge, and roofing slates upon the top. The next method I can understand was to dig the drain and fill it up with all kinds of trash; that gave a great

success for a number of years. The next method that I saw was the slate put on the bottom and the pipe molded in the shape of horse shoes, which was set down on the slate. That gave great success for a number of years. It still kept on improving, until they got to the round tile. In 1892 there was a piece of land on the outskirts of Birmingham. There were about 400 acres which were practically worthless. It was grown up with what they call thistles, as tall as myself, and it was fit for nothing. This 400 acres of land was sold to the Racing Committee. They drained 300 acres of this land, which ran along a hillside. The drains were put in 50 feet apart, 3-inch tile, 2 feet deep. That was to give a good drainage off the race course. In the summer-time they had the water-works laid on. At their notice they could turn on the sprinklers. The drains were to carry off the water. Then for a number of years I was interested in public works on large water mains; so, as I say, I have been interested in public work all my life. I was engaged by this firm to collect water off of about 600 acres of land. As near as I can tell, one hundred years ago this land got into such a state that they had to build ditches to carry off the water. Since I have been in this country I have been working on tile drainage.

PROFESSOR SHERWIN: I should have said in introducing Mr. Cowley that he is engaged in installing the largest system of tile drainage in the State of North Carolina at the present time.

SOME SPECIAL PROBLEMS IN TILE DRAINAGE

By H. M. LYNDE, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture.

Mr. President and Gentlemen: This subject of "Some Special Problems in Tile Drainage" has suggested itself to the speaker by the numerous questions which have come to our attention in our travels over the State of North Carolina in the interest of farm drainage. An attempt will here be made to present these problems, together with their possible solutions, with the feeling that perhaps they may be of assistance to others who may have like problems. Nothing original is offered in the way of solutions; they are simply the results of actual experience of those who have drained, and for this very reason ought to be the more valuable.

All over eastern North Carolina are many farms which have been in cultivation for a great many years, drained only by open ditches. The owners have no doubt many times complained of the expense of cleaning out these open ditches and the hindrance which they cause to farming operations. Perhaps one of them decides that he will try underdrainage. The first problem which presents itself is probably the expense, and whether it will pay to invest money for tile drainage. Last year the speaker presented a paper on "Tile Drainage As An Investment," and attempted to show that underdrainage does pay; but we have here today reports from persons who have tile drained, and the speaker will let them answer that question for you. Assuming, then, that

underdrainage is a profitable investment, what are some of the problems that may present themselves? Stating them briefly and afterwards discussing them, the following have occurred to the speaker as possible problems. These are by no means all the questions that will arise:

1. What kind of underdrain to use.
2. Shall cement or clay tile be used?
3. Is it best to lay tile in old open ditches?
4. How to prevent fine sand or silt from entering the tile.
5. Laying tile through quicksand pockets.
6. How to drain springs and seepage areas.
7. How to drain depressions which have no natural outlet.
8. Will tile become obstructed with roots?
9. How to drain farm premises such as cellars and stockyards.

KIND OF UNDERDRAIN

The landowner has no doubt heard of pole drains, box drains, stone drains, and tile drains. Which shall he use? Pole, box, and stone drains have been used to a considerable extent in the past, and where intelligently applied have given good service while they lasted; but of late years this form of underdrain has been practically abandoned because of their temporary character, usually becoming clogged with dirt in a few years. In clay land with good fall they work very well for a few years, but in sandy or loamy soil they are not satisfactory, because sooner or later the dirt works in between the stones or wood and obstructs the passage of the water. It is practically impossible to get a uniform grade so that pockets will not occur in which silt may collect. Furthermore, you cannot lay out a system of mains and laterals with these types of underdrains. Experience teaches us that they do not give uniformly satisfactory results. Undoubtedly, the best type of underdrain is tile. The difference in the cost of tile is well repaid by the permanence of the improvement, for when put down correctly they need no attention except to see that the outlet is not obstructed.

CLAY OR CEMENT TILE

Clay or cement tile: Which is the better? Which is the cheaper? One of the arguments made in favor of cement tile is that they can be made right on the farm where they are to be used, and that they can be made cheaper than the cost of clay tile. For this reason men are interested in the subject. The answer that we would give to this question is that cement tile, if properly made, are as good as clay tile, but no better. However, they should be made well or not at all, using a good clean sand, and the mixture should not be leaner than one part of cement to three parts of sand, and they should be thoroughly cured. If made properly, there is probably no profit in selling them at prices lower than the current prices of clay tile. If a man can make them in his spare time on the farm, it will probably be cheaper than buying clay tile; but if made at a factory, they cost about the same as clay tile in this State.

TILE IN OLD OPEN DITCHES

On farms covered with old open ditches the question often arises whether it will not be cheaper to lay the tile in the old ditches, thus saving the expense

of digging a new ditch. This again our experience teaches us it is not well to do. These ditches are often crooked, have poor grades, and are filled with several inches of soft sediment. They have been cleared out and deepened so many times that if they are deepened any more the outlet of the tile will be submerged. On the other hand, in endeavoring to secure a good outlet for the tile some of them are laid on soft material and they settle and become clogged. In either case poor results are obtained and in most instances it is better to dig an entirely new ditch. The cost of digging this new ditch will not be so expensive as it may seem, and experienced ditchers prefer this to trying to secure a good bottom in an old ditch.

PREVENTION OF DIRT ENTERING TILE

Where tile are properly laid on a solid bottom, the trench filled immediately afterward, and where there is a good outlet there should be no liability of the tile becoming clogged with silt or sand. In clay or loamy land no other covering than the material taken from the ditch is required. There are occasions, however, where tile are laid in fine or wet sand on a flat grade, where some precautions should be taken to prevent its entrance into the joints between the tile. In such cases a piece of tarred or building paper wrapped around each joint has been found to be satisfactory. This excludes the dirt or sand, but not the water. Of course, the paper may become rotten after a number of years and break to pieces when touched; but after the tile are once covered, there should be no need of disturbing them. After the material over the tile has become established, there is less danger of the dirt working into the joints. In laying tile in fine sand it is probably better to do the work when the soil is dry.

QUICKSAND POCKETS

In digging a trench for tile, small quicksand pockets are often encountered. Water may bubble up from the bottom of the trench for several days after it is opened. In such cases it will be well to wait a few days until the intensity of the flow diminishes. To prevent the tile from sinking or rising out of grade, lay strips of board right on the quicksand at the proper grade, and lay the tiles on these. Wrap pieces of tarred or building paper around the joints and cover with clay. The speaker had occasion to lay some tile through such a formation. The day the trench was opened up a board was laid to grade on the bottom and the tile laid on this board. The trench was left open overnight and the next morning, when examined, the tile had risen about 4 inches above grade, due to the pressure of the water and sand beneath the board. After a couple of days the tile were again set to grade and no more trouble was experienced.

DRAINING SPRINGS AND SEEPAGE AREAS

If the exact location of the spring can be determined, it can best be drained by tapping it directly; otherwise, the supply should be cut off by an intercepting drain. The intercepting system is also used in draining broad, flat areas which are wet because of seepage from the adjoining hillsides. The idea in such cases is to intercept the flow at the base of the hill land. In such cases the line of tile should be laid just above the line where the water comes to the surface. It will generally be found that the soil above the line

of seepage is of a more open nature than that below, the impervious nature of the soil below being the reason why the water comes to the surface.

In general, in laying out a uniform system of drains, the laterals are run in the general direction of the greatest slope. However, in sloping land which is full of springs and seepage areas, and where the soil is not homogenous, it may be better to use the diagonal system, which consists in running the laterals diagonally across the slope. In this way we get the benefits of both the intercepting and down-the-slope systems, the intercepting system cutting off the water before it rises to the surface and the down-the-slope method draining the land on both sides. The objection to the intercepting system alone is that it does not always drain the land on the lower side of the line because it is often lower than the drain.

DRAINAGE OF DEPRESSIONS WHICH HAVE NO NATURAL OUTLET

It is often found necessary to drain saucer-like depressions or ponds with no natural slope except toward the center, where water collects and stands for several days after a heavy rain. Very shallow depressions or those with a more or less open subsoil may be drained by running a line of tile through them and through the ridge to an outlet, to act as a main if laterals are necessary. Some depressions, however, have steep slopes and the subsoil may be of a very tight and impervious nature. The best method to employ in draining such areas is probably to install a surface inlet in the lowest portion to carry off the surface water as fast as it falls. Such a catch-basin consists of a well 18 inches or 2 feet in diameter extending to a distance of about 2 feet below the bottom of the tile and lined with brick, stone, concrete, or sewer tile, and covered with a grating and loose stones to prevent the entrance of trash.

The size of tile leading from the surface inlet will need to be larger than for ordinary soil drainage, since now much surface water is admitted almost as fast as it falls. Whereas, for ordinary soil drainage in this State, the size of tile required is based upon a run-off of one-quarter inch in twenty-four hours; when outside water is admitted to the system, the size of this tile should be so increased as to carry a run-off of 1 inch in twenty-four hours. In other words, if a surface inlet is installed in a depression which contains an area of 5 acres, to find the size of tile needed from the tables computed on a basis of a run-off of one-fourth inch per twenty-four hours, multiply this area by 4, which is 20 acres. Look in the table under the grade on which the tile are laid and find what size is needed to drain 20 acres. As an example, whereas a 4-inch tile on a grade of $2\frac{1}{2}$ inches per 100 feet will drain 5 acres of soil water, yet if surface water is admitted, its size should be increased to 6 inches.

OBSTRUCTIONS BY ROOTS

It is generally conceded that the roots of cultivated plants will not enter a tile that is dry for several weeks in the summer. The reason is that the plants are in search of moisture, and in such cases there is more to be found in the soil than in the tile. It is only when the drains receive water from a spring that runs throughout the year, and in times of extreme drought, when there is a deficiency of moisture in the soil, that there is danger of the roots of certain plants entering the tile. There is generally more danger from the roots of water-loving trees like the poplar, willows, alder, etc., than from

the roots of cultivated plants, and it is not wise to install, too close to these trees, tile which conducts water from a spring. If, however, it is found necessary to conduct water from a spring to a creek bordered by willows, alders, or other water-loving trees, it is best to use pipe with collars and cemented joints where the line passes through the land where these trees are growing. Also, it would be well to cut down the trees for a distance of 25 or 30 feet on each side of the line.

DRAINAGE OF FARM PREMISES

How many times do we see a stockyard so muddy that it is impossible to pass through it without sinking ankle deep in mud? Underdrains through such yards have no effect on them, because the surface becomes so puddled by the tramping of the animals that no water will pass through it to the drains. In such cases it might be well, after laying the drains, to fill the trench with cinders, gravel, sand, or some other porous material, and also cover the entire yard to a foot in depth, with cinders or gravel. The water will then readily reach the drains. The use of surface inlets at favorable points is also recommended.

A wet cellar or a wet foundation to a house is a sure cause of ill-health to its inmates. The whole site on which a house stands should be thoroughly drained. While the speaker realizes that the great majority of houses in the State have no cellars, yet how much more comfortable and healthy would the inmates be with a good dry cellar! Cellars excavated in clay lands are rarely dry without artificial drainage. The effort to prevent water from entering the cellar by cement or concrete walls often fails, and in any event is more expensive than draining. The method best adapted for draining a cellar is to intercept the water before it enters it. A line of tile placed beneath or outside the cellar wall and below the level of the cellar floor will intercept the water and prevent it entering the cellar. The tile should be laid on a slight grade all around the wall and conducted away through a main to a free outlet. By this means cellars can be kept effectively and permanently dry.

If any one present has encountered problems similar to the ones mentioned, or has had other difficulties, I believe we would all like to hear how they were overcome. I thank you.

DISCUSSION

QUESTION: Have you ever been able to find a practical ditcher for the individual farmer?

ANSWER: It depends on how much you have to do. If you have 100,000 feet of tile to lay, it would pay you to get one of these ditching machines.

PROFESSOR SHERWIN: These machines will go through stony land with pretty fair success. My attention has been called to the fact that there are on the table by the window several different bulletins, some by the Department of Agriculture and some by manufacturing companies, all relating to tile drainage.

Last year in the Drainage Convention Mr. Small, whom I think we might call the patron saint of the Association, introduced a resolution

asking the Agricultural Club at the A. and E. College to send a representative to the Annual Convention of this Association. Acting on this suggestion, the Club has sent a man who will give us a short talk on how to lay out a drainage system. This man is Mr. T. Y. Blanton, a student in drainage at the College.

HOW TO LAY OUT A DRAINAGE SYSTEM

By T. Y. BLANTON, Student in State A. and E. College.

Chart No. 1 shows a tile drainage system as laid out on a part of the State A. and E. College farm, West Raleigh, N. C. The field is bounded on the north by one of the roads which run through the farm. On the west it is bounded by an open ditch or gully in which water runs throughout the year. This ditch must be maintained on account of the accumulation of surface water.



Fig. 1

The water from this ditch enters Rocky Branch, which bounds the field on the south. On the east side of the field is an open dry ditch which must also be maintained on account of surface water. Both the drains have their outlets in this ditch, which carries the water to Rocky Branch. The general slope of the field is from the road to the south toward the branch, except along the branch on the south side and along the ditch on the west side. Here the slope is slightly to the north and east, away from the streams. This condition can be seen by field observation, and the fact is borne out by the contour lines on the chart.

All of this field is cultivated every year and it all produces some crop, but the lower portion does not produce a maximum crop. That this land needs drainage is evidenced by the cloddy and run-together condition of the surface soil. The shaded area on the chart shows the part of the field that needs drainage. The heavy broken lines show the drains as laid out by members of the class in drainage.

The surface of the land is such that two drainage units are necessary. Unit No. 1 consists of a main A with one lateral, and also a submain having one lateral. Unit No. 2 consists of a single line of tile, main B.

Beginning at the outlet (Station 1, Fig. 1), stations 50 feet apart, with extra stations at junctions, were staked out as follows: A short stake, 6 to 12 inches long, was driven down almost flush with the surface, at a point 2 inches from the edge of the proposed ditch. A long stake was then driven down by

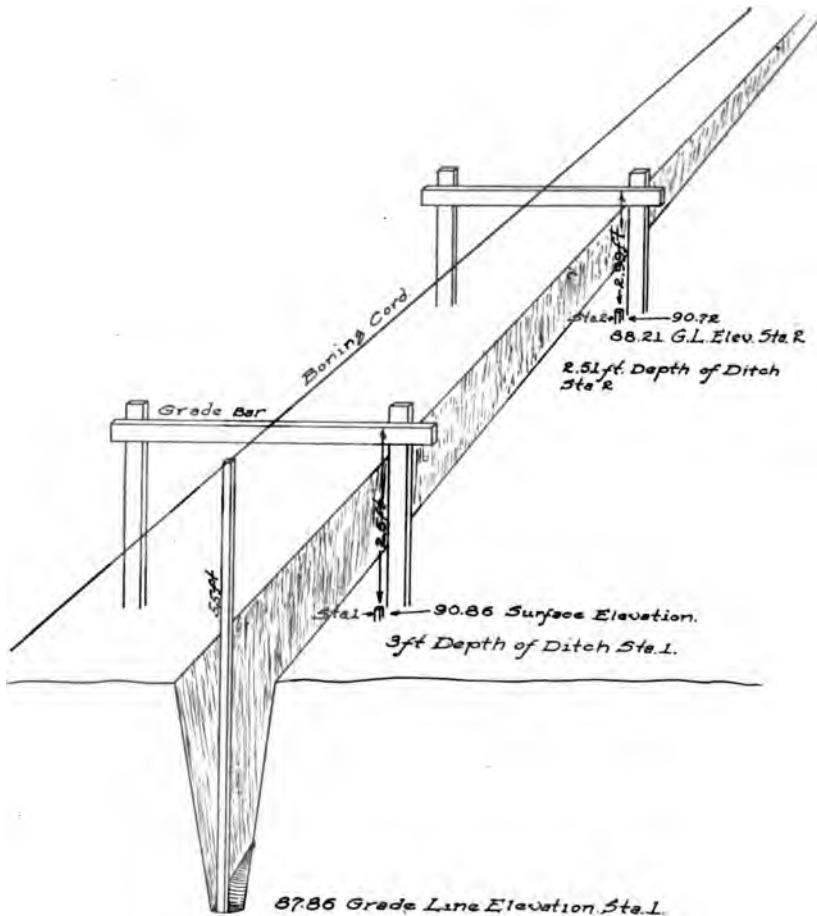


Fig. 2

the side of it. This stake should stand about 3 feet above the surface. It serves as a marker or finder. The short stake is for taking level readings and measurements from.

In laying tile it is necessary to have the grade or fall of ditch uniform, so that the flow of water will not be checked at any point and the tile become filled with silt. Now the surface is irregular, and if the ditch is dug the same depth all the way, the grade will not be uniform. To get a uniform grade we stretch a boning cord just over the center of the proposed ditch. The cord is stretched across grade bars, the height of which is determined as follows: Starting at the outlet, the ditch is to be 3 feet deep. The elevation at this point (Station 1, Fig. 2) is 90.86 feet. Subtracting 3 feet (depth of ditch)

from this, we find that the elevation of the grade line is 87.86 feet. The ditch is to be 3 feet deep at the head also. This elevation is 92.98 feet. Subtracting 3 feet, we find that the elevation of the grade line here is 89.98 feet. Now the difference in elevation at outlet and at the head of the ditch is 2.10 feet, the total fall. Dividing this by the number of 50-foot intervals gives the fall between any two 50-foot stations, which is .35 foot on main A. Adding .35 foot to 87.86 feet (elevation of grade line or bottom of ditch at outlet) gives 88.21 feet. This is the elevation of grade line at Station 2, and is .35 foot higher than the preceding station. Now subtracting grade line elevation of this station (88.21 feet) from the surface elevation (90.72 feet), gives the depth of ditch at Station 2, which is 2.51 feet. The depth of ditch can be found at each succeeding station in the same way.

Since we have found the depth of ditch at each station, we have only to subtract this depth from the length of our boning rod to find how high to place our grade bars above the surface. Thus, if we use a 5.5-foot rod the height of the grade bar will be:

5.5—depth of ditch = height at any station.

5.5—3 feet = 2.5 feet at Station 1.

5.5—2.51 feet = 2.99 feet at Station 2.

The height of all grade bars is found in this way, and the boning cord is stretched across them over the center of the ditch. Then by measuring down from the cord with the 5.5-foot rod all along the ditch, we can tell exactly when we have it to grade.

PROFESSOR SHERWIN: At the end of the current term I shall be obliged to give Mr. Blanton an examination in drainage. I want some of you here this morning to help me to do this by asking him questions.

Tile drainage as an investment has been touched upon at least twice this morning, and I want to emphasize at least one point in that connection. If we take \$25 per acre as an average cost of draining land, what is 6 per cent of that? It is \$1.50 per year. If you consider your tile drainage cost as an investment, you have got to get \$1.50 over your original yield on the land, which we will say is $1\frac{1}{2}$ bushels of corn. Tile drains, wherever used, increase the yields to an extent that is very easily noted—in fact, to an extent that the uninitiated will readily see the value of it. That increase of $1\frac{1}{2}$ bushels of corn, which is necessary to pay interest on the investment, is a very low increase from tile drainage, as any man in the room can tell. In measuring up corn from the field you cannot always tell the difference between 30 and $31\frac{1}{2}$ bushels. You do not notice the difference. I mention this as an illustration that tile drainage does pay very much more than giving us 6 per cent interest on the original investment. We invest in tile drainage because it gives us 60 per cent, or in some cases a great deal more on our investment. In fact, in some cases the increase is infinite, because it brings the profit up from nothing or less than nothing to a good paying crop.

REPORTS OF RESULTS OF USE OF TILE DRAINAGE

PROFESSOR SHERWIN: We had hoped to have here this morning men who could give us written reports on the results of their tile drainage. We have several reports, and I think perhaps there is some one in attendance who has done tile drainage and would favor us with a report.

MR. SCOTT: I have not used tile drainage but a little while, five or six years. I like it very well.

MR. JOHNSON: I cannot speak exactly from personal experience, though I have done some tiling. Referring to the proposition, "Does it pay to drain?" it seems to me you have left out two important features: one, I have not heard any reference to the fact that in maintaining these open ditches you have got to expend annually as much money as these gentlemen calculate is the interest on the money for tile drainage. In the second place, in our country, we figure that about 5 per cent of our total area is appropriated by open ditches and ditch banks. I know some farms where it may run 7 or 8 per cent. There is absolutely no question, to my mind, but what if we could do away with all these open ditches, in ten years we would derive from the land appropriated by these open ditches and ditch banks enough to pay the entire cost of tile draining. There are two problems, however, that arise with us: in the first place, the cost is great, and we have not always been able to raise the money to do it; and, in the second place, our land is so level, with thousands of acres with only an elevation of from 1 to 2 feet, and all of it being only 10 to 16 feet above sea level. It presents a problem that we have not so far been able to meet. In our own farm our rows are 2,650 feet long, and actual surveys of engineers have shown that nowhere in a farm of 300 acres is there an elevation of more than a foot, and our main canal is a mile from the drainage canal, which is something like 4 or 5 feet deep. Now the problem that we have confronting us is just how to cover that whole surface and still bring that water to the canal. Another problem is that after we have this solved for us, where are we going to get competent men to do the work. We can get the engineer and we can get the negro to dig the ditch, but when it comes to laying tile, we cannot find any competent man to do this; so it seems to me that a part of this work, and the work of this Association, lies along this particular line, to interest people who could actually perform the work. It seems to me that in that way we would promote tile drainage more than any other. I know that in my own county there would be thousands or hundreds of thousands of tile drain laid if it could be done by getting a contractor to do the work. I want to say that my brother-in-law owns a farm five miles from Belhaven which was tiled by his father-

forty or fifty years ago. There was originally 200 acres in this farm, with one canal running through it. He has no open ditches from his land, and I have never known his property to be injured by water but one time, when a cloudburst occurred and there was an unusual amount of water. He has had occasion when laying some new tile recently to cross some of these older sections, and he found them all in perfect working order. Recently he bought a farm adjoining his, which since my earliest recollection has been nonproductive. While this farm was high enough, and of a sandy nature, yet when the rain came it would all get drowned out. He had to go through a hill that was quicksandy in order to get tile in this field. He took plank and made it four-square, and covered his tile up. He finally got it to hold, and that farm is as productive as any other farm in that section, and I am persuaded that in the past four years it has paid for its tile drain.

Another point I would like to have made clear is this: The National Department and our State Department maintain men in Raleigh for the avowed purpose of helping us in our engineering work, and I think it would be of value to this company if these men would state the exact terms upon which we can obtain this engineering.

PROFESSOR SHERWIN: Mr. Johnson raises two questions: first, with regard to obtaining competent men to do the work of laying tile, and then how to get the services of the drainage engineers at Raleigh. I am going to answer the first question with regard to getting competent men. When you want a thing done well, the thing is to do it yourself; but if you do not feel like doing it yourself, you might raise up boys and train them in the way they ought to go.

MR. BAKER: The best teacher I have seen in North Carolina is Mr. Cowley.

PROFESSOR SHERWIN: I will ask Mr. Lynde to answer Mr. Johnson's other question as regards draining land with very slight fall.

MR. LYNDE: Tile could be laid on a very flat grade if done correctly, and on a solid bottom. Sometimes, for some distance, it is possible to lay tile absolutely level, provided it is not too long a distance; in that case the hydraulic pressure will cause the water to flow through the tiles. The first plan, of course, is to get a good outlet, and if you have a deep ditch, taking the elevation at the upper end and the elevation at the lower end, and work from the lower end toward the upper. The question is asked, What should be the minimum depth of the tile? Of course, 3 feet is about the best depth, but you could do with 2 feet.

In regard to our work in the State: About four years ago the United States Department of Agriculture and the North Carolina Department

of Agriculture formed a coöperative agreement to assist the drainage in the State along practically four lines of work: first, make preliminary examinations of drainage districts for those who desire to make drainage improvements; second, to assist farmers in the terracing of land; third, to assist farmers in tile drainage; and, fourth, to do some experimental work like determining the correct spacing and the water to take care of in a tile drainage system. For the benefit of the private engineers, I want to say that we do not compete with them in giving assistance to farmers. The only thing we do is to try to give assistance to representative farmers in different sections of the State, so that it may serve as an example in interesting other people in the vicinity to take up the same line of work.

QUESTION: If you include the cost of cleaning the ditches at least twice a year, would it not decrease the cost?

PROFESSOR SHERWIN: My recollection is that a paper on that subject was presented a year ago, which is now in press. When that comes out we can all get a mighty good idea of the answer to that question.

HOW TO GET A GRADE FOR TILE DRAINING WITHOUT THE HELP OF AN ENGINEER.

By H. COWLEY of Edgecombe County

In Fig. 3 A the line with the letters on it is supposed to be the ground level. First you get a good place for your outlet and then find out the depth you want to put in your tile. Then you put two stakes in A and B, as shown in the figure, and use a parallel rule and carpenter's level and fix A and B exactly level. Hold one boning rod on A and one on B and one on D, then take a

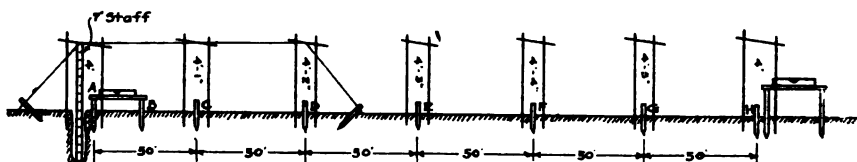


Fig. 3 A.

sight over boning rods on A and B, and drive stake D down till it is exactly level with A and B; or you can fix the one boning rod on stake H and drive it down till it is exactly level with A and B, and then drive down C, D, E, and F till they are all level with A and B. If you want to give it 2 inches fall in 100 feet you could put another stake in 6 inches above stake at H, and take out stake B that is of no more use. I always use a 7-foot staff (B). If you want your drain 3 feet deep, you put up your rail 4 feet at A; 4 feet 1 inch at C; and so on, as shown in the figure, till you get to H. You put that rail up 4 feet above the tallest stake; then if you want to go further on, you fix rule again the same as in the first place.

Fig. 3 B shows the boning rods. They are made 3 feet long, 3 inches wide, and 1 inch thick. The cross-bar is 1 foot long, of the same material; and the parallel rule should be made with $1\frac{1}{2}$ -inch material, width 6 inches, and 12 feet long.

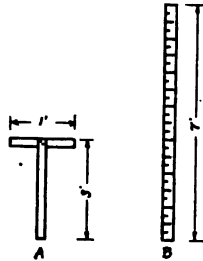


Fig. 3 B.

REPORTS ON TILE DRAINED FIELDS

MR. DODSON: I will just state that I have a piece of land that has two of those soft places in it. It has been absolutely worthless to me. It had never been in cultivation before. About three years ago, in the spring of 1914, we decided to put it in cultivation. I had a barn that was right next to the macadam road, and these depressions were north of that. There were anywhere from six to eight months of the year up to the time when I commenced this drainage project that there was water standing in those pockets. We made a 6-inch drain up into these low places, and where there were some depressions we cut out ditches and put in 3-inch tile. We used in all something over 1,500 feet of tile, and it drained three acres. We did not measure the corn which grew on it the first year, planted on July 4, but it was one of the best pieces of corn I have ever seen. Some of my oldest neighbors said they had never seen a better piece of corn grow. As I said, I did not measure the corn that grew on this land, but we did measure an acre which grew on a piece of adjoining land, which my son raised. On his acre we measured 56 bushels and 46 pounds of corn, as well as I remember. Now, this piece of tile-drained land was far ahead of that. After we took the corn off, we prepared the land and sowed it in wheat, and made 54 bushels of wheat on the three acres. After that we put it in peas and mowed the peas off for hay. I consider that one of the biggest investments I ever made. We ditched it out and made our own tile, cement tile. We had three long ditches; two went to the pockets and another to an upper portion of the land.

MR. E. N. HOLT: Tile drainage is the thing that we need in this country. The land that I have reference to is bottom-land that is very poorly drained. We ran two main drains up through the center

of this land. There were about $11\frac{1}{2}$ acres in the piece. The first year we broke it up we put it in corn, and it grew double what it did the year before. I feel sure it paid us the first year for doing the tile work.

PROFESSOR SHERWIN: Land which needs drainage responds to drainage. I want to quote Professor Thorne of the Ohio Experiment Station. He had been there something like twenty-five years. He said two or three years ago that at the beginning of their work they concluded that tile drainage was of first importance in bringing up the fertility of their lands; that humus and lime were second or third. He was not sure whether the humus was second or third, or the lime, but he was sure at that time that the tile drainage was first in importance, and he said at the end of twenty-five years experience he had seen nothing to change his view.

REPORT ON TILE DRAINAGE

By E. M. DODSON, Greensboro, N. C., R. F. D. 2

The plat here described is located $4\frac{1}{2}$ miles east of Greensboro, N. C., on north side of macadam road leading to Burlington, N. C., and in Guilford County, and contains 3 acres. The shape is as indicated by the attached plate. (Fig. 4.)

The soil is a fine sandy loam, changing to a stiff, sticky gray soil in the lowest parts. The subsoil is lightly streaked with pipe clay in lowest part to a yellow sand-clay formation on higher part.

The lot was considered worthless for agriculture because water was on the surface from six to eight months in the year on the low parts, and was a real mosquito incubator; so it had only been used for cattle pasture up to the spring of 1914. So in January, 1914, we decided to try to put it in cultivation by underdraining it. First we put in three main ditches and two laterals, as indicated by plate, altogether about 1,500 feet of tile 3 inches in diameter and 30 feet of 6-inch tile used at outlet into old ditch. The tile is from 30 to 42 inches deep in the land. We broke the land about 8 inches deep early in the spring with a two-horse turning plow, then disking well, then later re-breaking shallow with one-horse turning plow, then later harrowing again; and on July 3d harrowed with drag harrow, and on July 4th laid off with bull-tongue plow about 42 inches apart and planted with a corn planter 26 inches apart and used 75 pounds 10×4 acid and potash fertilizer per acre. In about five days ran drag harrow over it; the next week harrowed again, then used weeder for a week or two, then used cultivator five times in five weeks. The stand was almost perfect, and our oldest neighbor guessed it to yield all the way from 60 to 75 bushels per acre. Put it in wheat in the fall and made 54 bushels wheat, first quality, in 1915, and put back in wheat again that fall and made 45 bushels in 1916.

To make, the tile cost us about \$20. Ditching and filling cost about \$25. Total for the job, about \$45. Total cost per acre, \$15.

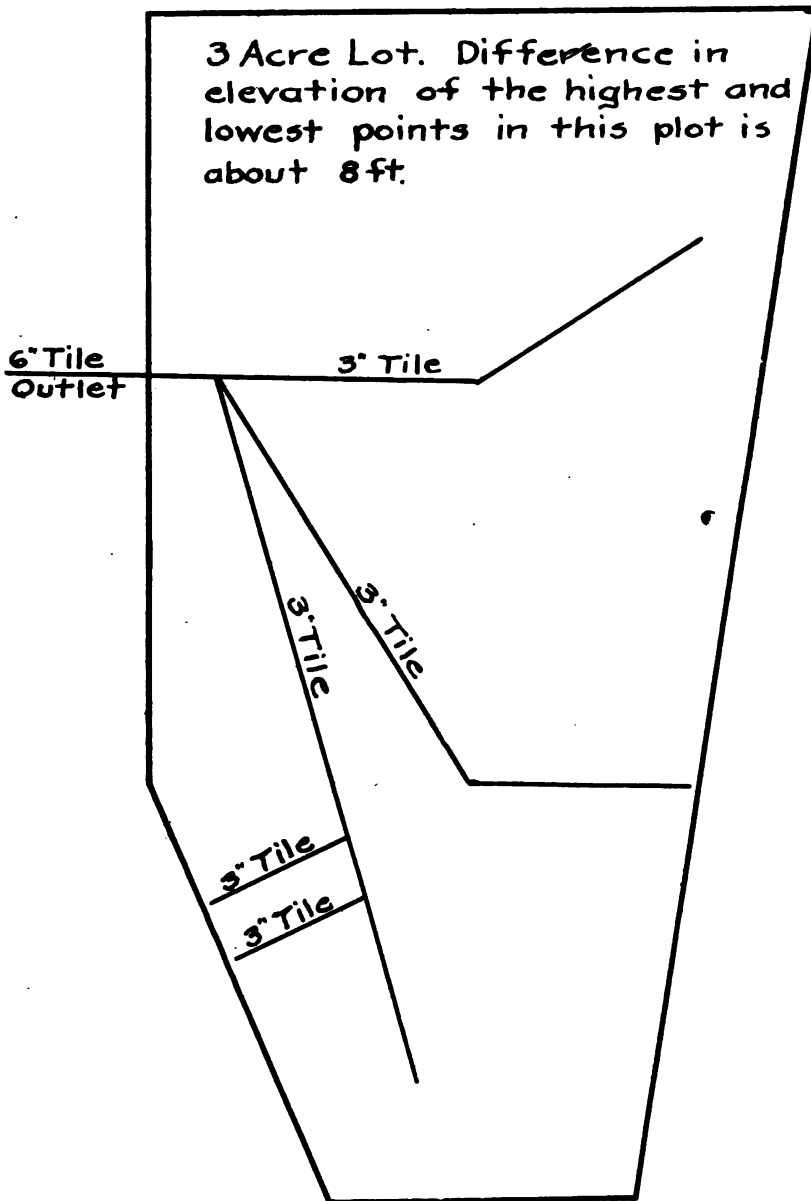


Fig. 4

TILE DRAINAGE*

By A. L. FRENCH, Draper, Caswell County, N. C.

Thirty years ago the writer did his first underdrainage work. The spot drained was a 2-acre "cat swamp" that occupied the center of one of the best fields on the farm where he was raised. The tile cost \$27. The cost of digging the ditches, laying the tile, and back-filling the ditches was not kept account of, for the work was done by the writer at odd spells, after school hours and on Saturdays, during the winter after he was 16 years old. These drains are working today, and mention is made of this first work to show when he began to lay tile and how lasting is the tile-drainage improvement.

Ten years ago there was on our farm in North Carolina a piece of land toward the side of a 30-acre field. The piece (about 4 acres) was underlaid with pipe clay overlaid with a stratum of hard-pan about 4 inches in thickness. The piece was fan-shape. A ditch was dug straight through the lowest portion of the piece 3 feet in depth at the outlet and 2½ feet at the upper end. The outlet is an open ditch on the land owned by a neighbor.

This main drain was dug the entire length and roughly graded before any of the laterals were dug, the clay being of a nature that it would not cave. Then each lateral was dug and graded to the bottom of the main ditch, beginning with those at the upper end of the field. The main drain was close to 40 rods in length, and the upper 20 rods was laid with 4-inch tile.

The work was begun at the upper end, the main being laid fast enough to make connection with each lateral as the ends of these were reached. The ditches were all carefully graded with a tiling scoop, and the connections of the laterals and mains were made by cutting a hole through the main and trimming the ends of the laterals so that they would closely fit the openings made in the main tiles. Small pieces of rock and broken tiles were packed around the connection also, to insure a tight joint. Care was used in grading the bottoms of the ditches to insure as straight a line as possible and an even grade, the latter being determined by the depth of water flowing in the bottom of the ditch.

When a ditch has been finished and the tiles laid, a spade was used to shave off clay enough from the banks of the ditch to cover the tiles about 4 inches deep, and this clay was closely packed over the tiles by tamping; then the balance of the back-filling was done with a team and road drag, except where the clay was the most "pipey," this part being done by hand.

When halfway down the length of the main ditch 5-inch tile was substituted for the 4-inch, to take care of the larger volume of water lower down.

The laterals were run 33 feet apart—as the clay was very stiff—and would average about 30 inches in depth. At the outlet a rock wall was built over the end tile and was built high enough so that surface water during flood-times would flow off either side and not right over the end of the tile.

Three hundred and thirty feet of 5-inch tile cost \$9.90, and the same number of feet of 4-inch cost \$6. Three thousand eight hundred feet of 3-inch lateral cost \$62.95, a total cost for tile of \$78.75. I consider these prices 50 per cent higher than they should be, but they were the best we could do.

The land previous to being drained was worthless, for nothing could be grown on it save swamp grass and poverty grass. Since being drained it

*This plan won the prize of \$10 00.

has been a good average field of the farm, without a ditch to interfere with tools of cultivation, where before deep ditches were used in an effort to do what open ditches will not do for that class of land, and crops have been 40 to 50 bushels of corn per acre, 25 bushels of wheat, $1\frac{1}{2}$ to 2 tons of hay.

No account of the time for doing the work was kept, for it was done during short spells in the winter when other work could not be carried on upon the land.

The whole cost of doing the work—estimated from similar work done on other fields—would probably be around \$35, making the total cost per acre, for tile and work, around \$28.

The first crop of corn grown on the land after the drainage was completed paid around \$30 per acre above cost of growing; so the crops that have been grown since that first year have had to bear no part of the cost of tiling the land.

This is only one of several experiences we have had during the past thirty years in underdraining land, as we do some of the work practically every winter.

REPORT ON TILE DRAINAGE

By I. H. TERRY, Rougemont, N. C.

I have a piece of land containing about six (6) acres in the northern part of Durham County, N. C., in eastern piedmont section. The same is in shape of a D, the outer edge of the round part being elevated about 8 feet, causing

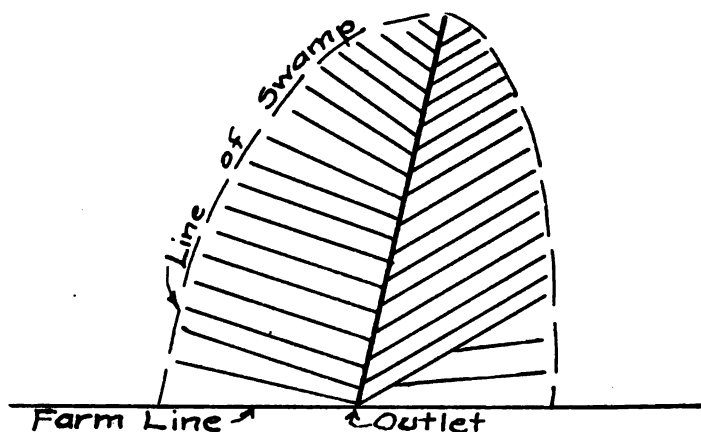


Fig. 5

a basin near center. It is gray soil with variable subsoil, part dark clay and part blue and yellow pipe clay. About twenty-five years ago this was drained almost perfectly with pole underdrain, and part of it yielded 20 barrels of corn per acre; but as pole drain became clogged or choked the yield was decreased till last year it was only about 3 barrels per acre.

As I saw the pole drain was not permanent and was losing two rows of corn by each open drain, I ordered last spring 1,600 feet of hard burned tile from Pomona, N. C., and with the aid of our assistant drainage engineer, Mr. Baker, laid the tile (5-inch main ditch and 4-inch laterals) in the latter part of April.

Owing to the wet spring and summer and the already sodden condition of the land, the yield was increased to only 6 barrels per acre. I know if I had not drained with the tile I would not have gotten a single mature stalk of corn, because my main ditch did not reach far enough up in basin under the knoll and I did not get any stand at that spot.

Have been laying pole drain for twenty years, and I consider, if this tile drain holds indefinitely, as claimed, and drains as it did for me this season, there is no comparison in price. The tile is so very much cheaper. I laid all the tile myself. The labor was \$14 and the tile cost me, freight and all, about \$50. But I know my yield was increased to 12 barrels on the 2 acres in the bottoms; so I consider the tile has just about paid for itself in this one wet season.

Now I feel, as it is permanently drained, I shall be repaid in bringing it back to its former yield of 20 barrels per acre, by cultivating and manuring.

By closing all open ditches, the appearance of this bottom has been improved at least 100 per cent.

RESULTS OF TILE DRAINAGE ON FARM OF T. N. SELLERS,
OF GUILFORD COUNTY

MR. JOSEPH HYDE PRATT,
Chapel Hill, N. C.

DEAR SIR:—In complying with your request of 28th inst., I am sending you herewith something of my experience in tile draining.

I undertook a piece of very wet bottom-land, covered with cat-tails, bul-rushes, and alders, and so soft in places that it was dangerous to attempt to cross it. There was a creek flowing through the length of this lowground. The land was higher at the banks of this stream, then became lower as you went from the stream on either side.

I went back from this stream 10 rods or more, cutting a ditch parallel with the creek and then cutting ditches from this into the creek at intervals of 15 rods or more, so that the tiling would not receive more water than it could carry. (I used 3-inch tiling only.) I soon had this land dry and firm. The production of this land since being thus drained is marvelous. The first crop was corn; and by actual measurement this first crop was 15 barrels per acre. Since the soil has become aerated more fully, I expect the next crop to make 20 barrels or more.

I followed that first crop of corn with wheat, disking up the soil when the corn was cut, and sowing 5 pecks of wheat per acre. I harvested 32½ bushels per acre.

Although I was told by the incredulous, when undertaking this work, that "a fool and his money are soon parted," yet I never made an investment that paid bigger dividends, and I never accomplished a work that yielded more lasting benefits.

I have placed nearly 1 mile of tiling, and shall continue till all my wet land is drained. Laying tile is not such a bugaboo as some will tell you, but my advice is to read all the bulletins and all the literature on the subject available; then buy the tools, embark in the work, and you soon become an "old stager," or think you are.

Very respectfully,

T. N. SELLERS.

REPORT ON TILE DRAINAGE

By E. N. HOLT, Greensboro, N. C., R. F. D. 2

1. The area of this drained field is 127,180 square feet, between two hillside fields, with a spring branch zigzagging through the middle.

2. Located between two hills near the McConnell road, a valley about 3 acres long, narrow at places, and wide at others. Dark gray rich bottom soil, with blue clay subsoil.

(a) This bottom in the year of 1911 was an awful thicket, the main ditch, as you will see in the drawing, was grown up in trees from one end to the

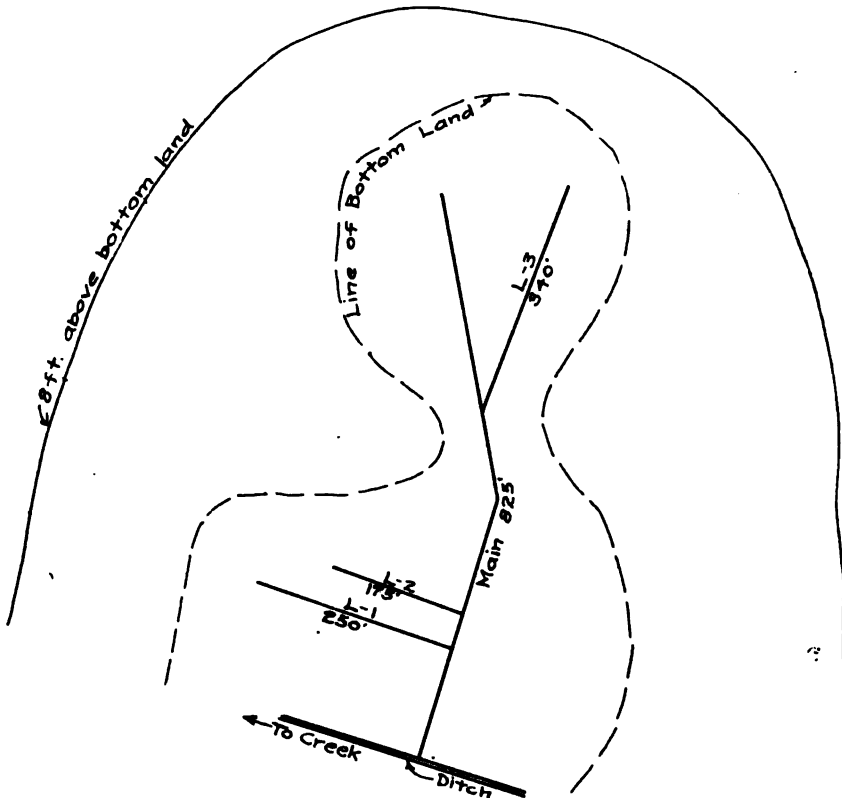


Fig. 6

other; willows, vines, button bushes, had full charge of it. In 1912 it was cleared and ditched; part was ditched before clearing in order to drain out so it could be cleared. In 1913 the ditches were cut and left open to drain until, in the fall of 1913 and the spring of 1914, these ditches were tiled and worked up for corn, which was the first crop cultivated on the bottom. Made an average of 50 to 60 bushels of corn per acre the first year in cultivation.

(b) In 1915 this corn stubble was plowed under in March with a two-horse plow, then seeded down in spring oats, orchard grass, and red clover. The oats reached the height of 2 to 3 feet. Made hay out of the oats which averaged from $1\frac{1}{2}$ to 2 tons of hay per acre. The following fall mowed a ton of clover hay per acre.

(c) In 1916 got two cuttings, and each cutting received a ton per acre; at present a good sod of orchard grass ready for grazing.

(d) Number of tiling laid, 1,043 feet; size of tile, 3 inches. We made our tile out of sand and cement. Cost without sand, labor and cement made our tile come to \$2 per hundred, \$20 per thousand. Cost of ditching, paid 20 cents per rod to have a foot-wide ditch cut, depth not limited. Back-filling was done with day laborers. It will cost from \$25 to \$50 per acre, probably more, to have thoroughly drained.

This report and drawing is very near exact.

JOSEPH HYDE PRATT,

WILMINGTON, N. C., November 9, 1916.

Chapel Hill, N. C.

DEAR SIR:—In regard to your letter of the 2d inst., will say I have about 3 miles of drain tile in my farm; and will say, without it would have to stop farming. I put down 6,000 feet twenty-five years ago of $2\frac{1}{2}$ -inch tile, and later on I used 3-inch altogether.

Tile put down 60 feet apart from 2 to 3 feet deep on ordinary land will be sufficient for good crops. I put my tile in the lowest places where I knew it would be unsafe without. The land I put my tile in was a gray sand on top and a black sand subsoil.

In putting down tile be sure to get a perfect fall. Sometimes I have put it down when I would have to haul water and pour in the trench the tiling scoop left so as to be sure of a perfect fall.

My $2\frac{1}{2}$ -inch tile cost me \$10 per thousand at the factory, and 5 cents per yard to put it down. My 3-inch tile cost \$20 per thousand, and 6 cents per yard to put it down. I can make a satisfactory crop of anything ordinarily, and without tile it would be practically naught.

If there is any more regarding tile I can tell you, will be glad to do so.

Yours very truly,

(Signed) D. G. NORTHROP.

SCOTLAND NECK, N. C., November 12, 1916.

DR. PRATT.

DEAR SIR:—I received a letter from the Agricultural Department asking for a plan on drainage of wet land. We have not had very much of this to do on our farm—only just an acre or so in the bottoms. We had an acre of land that for a good many years didn't make anything. We dug a ditch $1\frac{1}{2}$ feet deep, 18 inches wide, and put fat lightwood stobs crossed in this about every 5 feet apart and put green pine poles split open, one on each side and one in the middle, and wrapped these up with old sacks and burlaps which formed a sifter for the water to drain through, and finished filling this up with dirt. This ditch filled in this way has done good work for the past eight years, and we have made good crops each year on this acre of land and have had no trouble at all. This took one and one-half days work and the output in

money was not anything. This is a good plan for those who have no capital to start with. Tilage in our section costs a great deal of money to start with.

I hope this plan will help some one who has no money to put out in this work. I remain

Your friend,

JOHN SAMUEL HUDSON.

REPORT ON TILE DRAINAGE PROJECT*

By LAWRENCE L. CONNOLLY, Member Boys' Corn Club of Ledger, N. C.

DR. JOSEPH HYDE PRATT,

November 15, 1916.

Chapel Hill, N. C.

DEAR SIR:—Enclosed you will find sketch of a piece of wet land which I wish to drain, using 4-inch drain tile for the work.

The ditch is now almost completed and 400 feet of the tiling has been laid. The whole job will be completed, if weather will permit, in the next few days.

There is about 2 acres in the plat. There is a creek running through a long valley and almost through the middle of the level land. Both sides of the

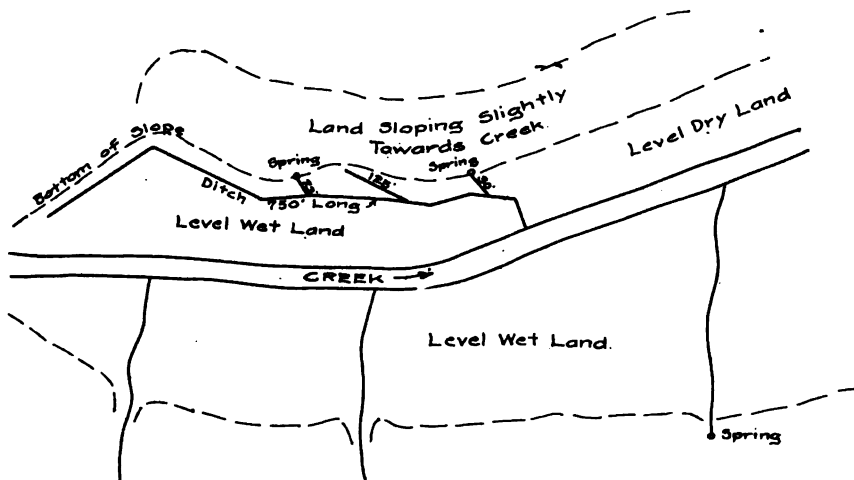


Fig. 7

creek are wet. The water comes from the foot of the hillside, and I am laying the tiling all the way in one continuous ditch, as per sketch, along the foot of the hill.

Soil is settling from the hillside and mountains at the head of the creek. This land is very rich. Has a black loam and pipe clay subsoil.

This land has been too wet to use for anything and has just been grubbed out last spring. Has had no crops grown on it except swamp grass.

The main ditch is 750 feet long, with three small ditches running into same. One of these is 125 feet, one 30 feet, one 23 feet, making in all 928 feet.

Am using 4-inch tile costing \$30 per thousand feet. Labor and tiling costing near \$75, or about \$37.50 per acre.

*This plan received the gold medal.

As stated, I have followed a line as near as possible to the hillside and have only one outlet into the creek. I have cut this ditch to the gravel and below in most places, same being on an average of not less than 3 feet deep. Am laying the tiling and at each joint am laying a rock on each side of the joint so that it cannot have any chance to move or get out of its place; then I am taking fine gravel and rock and laying around the tiling to about 2 to 3 inches over the top of same, and then I am taking some of the swamp grass near by and laying some of this on the rock to hold the wet dirt out of the joints of the tiling till same gets to working good. I think that this rock around the tiling will give the water a free access to the tiling and at the same time will keep the ditch from filling too tight around the tiling.

Filling in with rock around the tiling is an idea of my own, and I do not remember any of the farm papers recommending this; but I cannot see why it will not be an advantage to the ditch. Would like to have your idea on this.

I wish to enter this piece of ditch to compete for the gold medal. This is not only giving the plans for doing same, but I am actually doing the work.

The following letter has been received from Lawrence L. Connolly, acknowledging receipt of the medal, and giving further data in regard to his tile drainage:

LEDGER, N. C., December 4, 1916.

DR. JOSEPH HYDE PRATT,
Secretary North Carolina Drainage Association,
Chapel Hill, N. C.

DEAR SIR:—I wish to thank you for the award of the gold medal at the Drainage meeting in Greensboro. I certainly do appreciate this, as there must have been some other good plans to compete against.

As stated, I did not have all of this tiling laid when I submitted my report on same. Since then I have finished the main ditch of 750 feet, and the next good day or so I will finish getting in the two small branch lines that are lacking.

I will be glad to report results of this work from time to time. The main line is doing extra well and is carrying a good stream of water.

Yours truly,

(Signed) LAWRENCE L. CONNOLLY,
Member Corn Club.

REPORT ON TILE DRAINAGE PROJECT

By WILLIAM PAGE, JR., Morrisville, N. C., 16 years old.

DESCRIPTION OF FIELD TO BE DRAINED

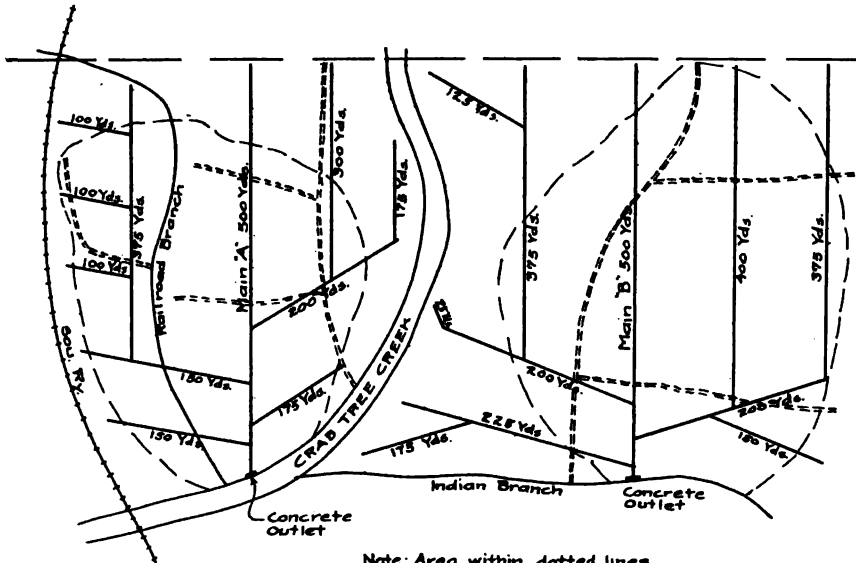
The field is located on Crabtree Creek near Morrisville, N. C., Wake County. It is a nearly square field, containing approximately 82 acres. It is a flat lowground field, with a dark loam soil, and a clay subsoil, and is nearly level over the entire piece, with the exception of a rise of about 6 inches to 100 feet, and a few low places shown on sketch of field.

The land is used to grow corn at the present time. It makes good corn in a dry year, but in a wet year it is near to a failure, for the corn drowns out.

The field has several ditches that may be removed if the drains were put in as shown in the sketch. The ditches are the only means of natural drainage, and they are not satisfactory in a wet year.

The sketch will be found on a separate sheet, showing present ditches which may be taken out, and the length of each main and each lateral.

The number of feet of tile required for each line are as follows: 500, 400, 375, 375, 125, 150, 175, 225, 200, 200, and 25 yards—2,750 yards in all on the east side of creek. The west system is as follows: 500, 300, 175, 200, 175, 375,



Note: Area within dotted lines
is low land.

== Present Ditches to be abandoned

Fig. 8

100, 100, 100, 150, 150 yards—2,325 yards in all. On the west side there is one concrete outlet, and one on the east side, which cost \$5 each.

The cost of the tile is approximately \$25 per 1,000 feet, which makes the tile cost about \$308.

The digging and back-filling of the ditches cost about 9 cents per linear yard, which is about \$45.67. The total cost is as follows:

5,075 yards of 4-inch tile.....	\$ 308.62
Two concrete outlets.....	10.00
Digging and back-filling.....	45.67
Total	\$ 364.29

Cost per acre, \$44.42

REPORT OF COMMITTEE ON TILE DRAINAGE

PROFESSOR SHERWIN: My recollection is that the awards were to have been made by the President. As chairman of the committee on these Tile Drainage Contests, I will make the report. The committee consisted of five besides myself. There was Mr. Lynde, Mr. Baker, Mr. T. E. Brown, and Mr. Cowley, who judged the papers. The papers were nearly all meritorious and the competition was so close that while we did not draw straws to decide it, we might not have done any worse if we had drawn straws for the final decision between the men. The final decision in the men's contest gave the favor to Mr. A. L. French. Mr. French reported everything shipshape and probably with more completeness of detail than any other contestant. It seems rather unfortunate in the face of so close a contest that the sum is not sufficient either to divide or that there are not other prizes to be awarded for second, third, etc., as long as extreme merit lasts.

In the case of the boys' award it was decided to give it to Mr. Lawrence L. Connolly of Ledger. The contest was close here, as in the case of the men's contest. That medal will have to be made up for the occasion; we cannot hand it out today, because it has to be made up, engraved with the name of the person, etc. It is our expectation that these contests are going to develop a considerable interest in drainage among the boys, and probably it is more worth while that the boys' and young men's interest be stimulated than the older men, because of the fact that they have longer to work out their energy and their plans in the draining of land.

MR. T. E. BROWNE: As a representative of the Boys' Agricultural Club work, I want to learn the facts governing this contest. I want to assure the Association that within the next year we are going to call the boys' attention to this. I was especially struck with the knowledge indicated in these papers by the boys. In our meetings and literature we are going to emphasize this work and call their attention to it.

DR. PRATT: I want to make one statement in regard to the papers, that you brought out partly. There were sent out to various persons interested in tile drainage a sheet which stated certain things the report should include, and the judges had to take into consideration whether the papers followed the rules and regulations governing the contest.

MR. JOHNSON: I want to thank our efficient Vice-President for the very instructive and comprehensive session which he has prepared for us, and I want to thank the various speakers for their words of encouragement and instruction. I have been especially impressed with the two papers that have been read in our hearing this morning. I feel that this Convention could well afford to spend not one morning, but

a day or two in the discussion of this very important subject of tile drainage. What we have is certainly good. There is much we can yet learn about this tile drainage, but I do believe and trust that what we have heard this morning will encourage us to study the subject of tile drainage. If each one of us will go home, as a committee of one, resolved that we will try to encourage it in our various communities, in a little while tile drainage will be a reality. While we have had a rather small Convention in numbers, it is gratifying to know that we have 71 persons registered during the two days session. We have 21 counties represented and we have representatives from the States of Georgia, Ohio, and the District of Columbia. There are representatives of the Seaboard Air Line and Southern Railways here. There is one thing that I feel should be mentioned in this Convention. Notwithstanding the fact that we have agricultural papers in our State, designed, as they claim, to improve agricultural conditions throughout the State, looking for subscriptions to men who are interested in agriculture, it is yet a sad fact that there are no representatives of these papers in this Convention, nor, barring the one we have in Raleigh, have I ever seen a representative of an agricultural paper at a drainage Convention. It seems to me that these papers are losing sight of the fact that in ignoring these conventions they are ignoring the strongest factor for agricultural development in our State, and I believe their attention ought to be publicly called to this fact. Therefore I mention it. Next year when this Convention shall meet I hope and I believe that we will have a large representation. I think this year a great many of us who have been charged with the duty of getting the people to attend have rested, in a measure, confident in the belief that if the people would only be so interested, they would come anyhow; but I want to say that next year, if I live, I want to make it my particular business to see that my community is represented more fully than it is this year.

I do not know of any further business that is to come before the Convention at this time, other than the reports of the committees, but since, in a measure, this is an experience meeting, if there is any gentleman present who would like to have something to say, we will be glad to hear from you.

MR. LYNDE: I would suggest that the two tile drainage papers receiving the awards be sent to the editor of the *Progressive Farmer* for publication in his paper.

MR. RANDOLPH: I would like to say to the Convention that while our college (Elon) does not attempt to do more than literary work, yet in our scientific departments we are especially interested in agriculture and in giving our boys and girls a fundamental idea of its

principles. I have been very much interested in the sessions of this Convention and have gained some ideas which I would like to take back with me.

QUESTION: I would like to ask one question, and that is how we are going to get labor to carry out this drainage work, and also to carry on the farm operations after the land is drained.

MR. JOHNSON: In our immediate section the land is so fruitful when cleared that we are justified in paying large sums for contract work, and any negro who will half work can earn \$2 per day for an eight-hour day. This fact has become more generally known throughout the eastern sections, and for this reason we have a great deal of negro labor; but it is only fair to state that in drawing on this labor from other sections it is not treating those sections exactly fair. So far, the foreign labor has been extremely unsatisfactory. We have had some Russians and Poles and a scattering of other nationalities. In nearly every case they were dissatisfied. This labor problem is one that no one has as yet found a solution for. To give you some idea of about what it costs to develop an acre of land, we pay \$8 per acre for cutting down, \$5 per acre for the lateral ditches, perhaps \$1.25 to \$1.50 to stick the corn. It will cost perhaps \$2 to cut the weeds in it one time. That embraces all the work. It will cost 50 cents per barrel on the average to raise the corn. The land will average anywhere from eight to twelve to fifteen barrels per acre, and we have not sold any of that corn for less than 80 cents per bushel. You can readily see, if you take an acre on which you have invested, say \$25, and you can sell all the crop off of it for \$50 per acre, what it means. Would it not be a good plan to cut these large farms into small farms, and induce the people of the west to come there instead of going to Canada? Land now sells for \$30 per acre uncut, that is, with the wood still on it.

REPORTS OF COMMITTEES

REPORT OF COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

We, the Committee on Nomination of Officers and Next Meeting Place, beg leave to submit our report as follows:

Place for next meeting—Lumberton, Robeson County, N. C. That a mid-winter meeting be held in Raleigh, N. C., the dates to be decided on by the Secretary.

For President—Professor M. E. Sherwin, of Wake County.

For Secretary-Treasurer—Dr. Joseph Hyde Pratt, of Orange County.

For First Vice-President in Charge of District Drainage—D. B. McNeill, of Robeson County.

For First Vice-President in Charge of Farm Drainage—H. M. Lynde, of Wake County.

For Second Vice-Presidents—E. Oscar Randolph, Alamance County; P. H. Johnson, Beaufort County; O. L. Clark, Bladen County; H. B. Craven, Buncombe County; J. A. Scott, Cabarrus County; R. L. Rockett, Catawba County; J. A. Brown, Columbus County; W. F. Aberly, Craven County; Hersey Everett, Cumberland County; Bennehan Cameron, Durham County; H. Cowley, Edgecombe County; N. L. Cranford, Forsyth County; W. C. Boren, Guilford County; Dr. C. A. Statesbury, Hyde County; Lovit Hines, Lenoir County; W. D. Alexander, Mecklenburg County; J. L. Becton, New Hanover County; Miss H. M. Berry, Orange County; W. A. Brown, Pender County; Bruce Craven, Randolph County; J. B. Sellers, Robeson County; V. T. Baggett, Sampson County; C. Bodenheimer, Stokes County; F. R. Baker, Wake County; J. H. Stallings, Wayne County.

Vice-Presidents from other counties are to be named by the Secretary-Treasurer.

MR. SELLERS: I move that the Secretary be instructed to cast the entire vote of this Convention for the officers as given by this Nominating Committee.

Motion carried.

REPORT OF COMMITTEE ON RESOLUTIONS

The North Carolina Drainage Association, in annual session in the city of Greensboro, North Carolina, submits the following declaration and resolutions in behalf of the public activities to which it is committed. This Association was organized in the city of New Bern in 1908 for the purpose of promoting the reclamation and more efficient drainage of wet and overflowed lands in the State. As a result of the coöperative efforts of this Association, a modern drainage law was drafted and enacted into law by the General Assembly of the State at its session of 1909. Under this law as amended from time to time many drainage districts have been established, many thousands of acres of wet and overflowed lands have been reclaimed, and many other thousands of acres of lands which were subject to occasional overflow and consequent damage to growing crops have been efficiently drained; and all these lands are now in a productive condition. The net results of these activities represent an increment to the wealth of the State estimated by some as high as \$50,000,000, thereby increasing the revenues of the State and counties and multiplying the volume and value of farm products and contributing to the welfare and prosperity of the people.

We urge upon the intelligent and progressive citizenship of the State a continued interest in the work of the Association, particularly by attending its sessions and participating in the educational processes intended to extend the benefits of drainage to every locality.

We commend to the Legislature of the State due consideration of the importance of maintaining a wise and workable drainage law, and we express the hope that certain amendments which will be proposed to the Legislature at the coming session of 1917 will be promptly enacted into law. To this end we urge the Association at this meeting to authorize and direct the Legislative Committee to hold a meeting in the city of Raleigh during the coming session of the Legislature at such time as may be designated by the President

and Secretary of the Association for the purpose of presenting to the appropriate legislative committees the necessity for these amendments and their enactment without material change.

That the President and Secretary of the Association be requested to exercise unusual efforts by way of publicity and correspondence to secure a large and representative attendance of citizens at the next annual meeting of the Association.

That this Association extends cordial thanks for many courtesies extended in preparation for and during the sessions of this Convention in the city of Greensboro. We especially thank the Chamber of Commerce for its coöperation, the Board of County Commissioners for the use of the courthouse for the sessions of the Convention; the press of the city for their generous reports of the proceedings; the Manufacturers' Club for courtesies extended; and all those citizens of the city of Greensboro who have participated in welcoming us and in making our stay so agreeable.

JOHN H. SMALL, *Chairman*,
 BENNEHAN CAMERON, Durham County,
 W. C. BOREN, Guilford County,
 E. WILLIAMSON, Sampson County,
 W. F. ABERLEY, Craven County,
 J. A. WILKINSON, Beaufort County,
 N. L. CRANFORD, Forsyth County,
 A. E. HIRE, Forsyth County,
 G. B. SELLERS, Robeson County,
 JAMES SLATE, Stokes County,
 BRUCE CRAVEN, Randolph County,
Committee on Resolutions.

The report of the committee was accepted and the resolutions as presented were unanimously adopted by the Convention.

RESOLUTIONS OF SYMPATHY

At the Eighth Convention, held at Belhaven, a resolution of sympathy was sent to Mrs. B. E. Rice, on the death of her husband, one of our most valued members. The following letter was received from Mrs. Rice in reply:

MR. JOSEPH HYDE PRATT,
Chapel Hill, N. C.

WENONA, N. C., January 24, 1916.

DEAR SIR:—Your note of December 22d was received by me some time ago, also the copy of resolutions adopted by the Drainage Convention. The sentiment expressed in the resolutions was greatly appreciated by myself and family. Also I wish to thank you for your kind expressions of appreciation of my dear husband's work. Your kind words are very comforting.

Again thanking you, I am,

Very sincerely,

(Signed) MRS. B. E. RICE.

On the death of Mr. William Milholland, the following resolution was passed, and forwarded to Mrs. Milholland of Norfolk, Va.

RESOLUTION

Resolved, That this Association expresses its deep regret at the death of our esteemed former member, Mr. William Milholland, and its appreciation of his faithful work in coöperating with our Association in the development of the State; and the Secretary is herewith requested to extend the condolences of this Association to the bereaved family.

REPORT OF MEMBERSHIP COMMITTEE

The Membership Committee reported a total registration of 71 from the following 21 counties:

Alamance, Beaufort, Buncombe, Cabarrus, Craven, Catawba, Durham, Edgecombe, Forsyth, Guilford, Hyde, Lenior, Mecklenburg, New Hanover, Orange, Randolph, Robeson, Rowan, Sampson, Stokes, and Wake.

There were also representatives from Georgia, Ohio, and Washington, D. C.

A complete list of the registration is given at the end of the proceedings.

MR. JOHNSON: I would like now to turn over the Convention to its next President, Professor M. E. Sherwin of Wake County.

MR. SHERWIN: I thank the Association very heartily for this honor, but I will forego any presidential address, the same as I did the vice-presidential address.

The Convention adjourned *sine die*.

**DELEGATES WHO REGISTERED AT DRAINAGE
CONVENTION, GREENSBORO, N. C.
NOVEMBER 22 AND 23, 1916**

<i>Name</i>	<i>Town</i>	<i>County</i>
W. F. Aberly.....	New Bern	Craven
Will D. Alexander.....	Charlotte	Mecklenburg
Eugene Baggett	Salemburg	Sampson
V. T. Baggett.....	Salemburg	Sampson
F. R. Baker.....	Raleigh	Wake
J. L. Becton.....	Wilmington	New Hanover
H. M. Berry.....	Chapel Hill	Orange
J. B. Blades.....	New Bern	Craven
T. Y. Blanton.....	West Raleigh	Wake
W. C. Boren.....	Pomona	Gulford
D. Tucker Brown.....	Chapel Hill	Orange
T. E. Browne.....	Raleigh	Wake
W. S. Bullard.....	Roseboro	Sampson
Bennehan Cameron	Staggville	Durham
Wm. R. Camp.....	Raleigh	Wake
J. H. Clinard.....	Winston-Salem	Forsyth
A. Wayland Cooke.....	Greensboro	Gulford
H. Cowley	Tarboro	Edgecombe
N. L. Cranford.....	Winston-Salem	Forsyth
Bruce Craven	Trinity	Randolph
H. B. Craven.....	Ridgecrest	Buncombe
P. H. Cranford.....	Greensboro	Gulford
Cheater Dodson	Greensboro	Gulford
E. M. Dodson.....	Greensboro	Gulford
J. C. Forrester.....	Greensboro	Gulford
Cyrus P. Frazier.....	Greensboro	Gulford
D. L. Fullerton, The Tillotson & Wolcott Co.....	Cleveland, Ohio	
W. F. Goodman.....	Concord	Cabarrus
J. R. Hardin.....	Greensboro	Gulford
Lovit Hines	Kinston	Lenoir
E. N. Holt.....	Greensboro	Gulford
Jos. A. Hoskins.....	Summerfield	Gulford
E. E. Hunter (S. A. L. Ry.)	Wilmington	New Hanover
C. H. Jessup.....	Peters Creek	Stokes
P. H. Johnson	Pantego	Beaufort
Wm. M. Jones, M.D.....	Greensboro	Gulford
A. W. Jordan.....	Greensboro	Gulford
Andrew Joyner	Greensboro	Gulford
H. M. Lynde.....	Raleigh	Wake
Rory McNair	Maxton	Robeson
D. B. McNeill.....	Lumberton	Robeson

<i>Name</i>	<i>Town</i>	<i>County</i>
R. J. Mebane.....	Greensboro	Guilford
S. A. Miller.....	Winston-Salem	Forsyth
W. E. Miller (P. O. Box 232) ..	Greensboro	Guilford
L. Moseley	Greensboro	Guilford
W. S. Needham.....	Barber	Rowan
R. E. Parker.....	Raleigh	Wake
Joseph Hyde Pratt.....	Chapel Hill	Orange
E. Oscar Randolph.....	Elon College	Alamance
W. A. Reynolds.....	Winston-Salem	Forsyth
Otis M. Rockett.....	Greensboro	Guilford
R. L. Rockett.....	Conover	Catawba
J. A. Scott.....	Concord	Cabarrus
Howard See .....	.....	Atlanta, Ga.
G. B. Sellers.....	Maxton	Robeson
J. B. Sellers.....	Maxton	Robeson
T. N. Sellers.....	Brown Summit	Guilford
M. E. Sherwin.....	West Raleigh	Wake
James W. Slate.....	Mizpah	Stokes
John H. Small.....	Washington	Beaufort
W. B. Stafford.....	Winston-Salem	Forsyth
C. A. Statesbury.....	New Holland	Hyde
M. W. Thompson.....	Greensboro	Guilford
John D. Waldrop.....	Greensboro	Guilford
M. C. Henley.....	Greensboro	Guilford
J. C. Williams (South'n Ry.) ..	.....	Washington, D. C.
Arthur Williamson	Salemburg	Sampson
E. Williamson	Salemburg	Sampson
Hiram B. Worth.....	Greensboro	Guilford
W. H. Worth.....	Greensboro	Guilford

PRESS NOTICES

Since the drainage meeting in November, 1916, the following press notices have been prepared and sent to the press:

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY FORESTRY DIVISION

Press Notice No. 42.

CHAPEL HILL, N. C., November 25, 1916.

DRAINAGE DISTRICTS AND FOREST FIRE PREVENTION

At the Drainage Convention just closed at Greensboro, Dr. Joseph Hyde Pratt, Secretary, brought out in a short talk the fact that enforcement of the State Forest Fire Law is of primary importance to those who are interested in drainage districts. As, however, swamp lands are not generally considered very susceptible to fire, the connection may not at first sight be obvious.

The establishment of drainage districts means the making available for agriculture of large areas of swamp land and the necessary throwing upon the market of large quantities of swamp timber. In Eastern North Carolina probably 90 per cent of such timber is gum, for which, even though much is now cut for lumber and veneer, there is as yet but a limited market. The recent demand for timber for paper pulp throughout North Carolina is opening up another and very important market for gum timber, and, as small sizes are just as valuable as the large timber for this purpose, this use for gum will soon become general and undoubtedly very profitable.

Capital is now seeking investments in North Carolina gum lands, with the object of locating pulp mills here. The State Geological and Economic Survey has on file a number of letters from different parts of the country inquiring about suitable sites for such mills. That the interest is real can be seen from the fact that two exhibits of pulpwood were made at the State Fair: one by the Belhaven Board of Trade and the other by parties who are endeavoring to bring a pulp mill to Wilmington. The journal, *Paper*, the official organ of the Technical Association of Pulp and Paper Industry, also sent an exhibit, which unfortunately arrived too late to be shown.

The manufacturing of pulp requires a very large investment, and capitalists are unwilling to locate a mill where there is not a good prospect of a permanent supply of timber. Swamp land which is to be drained and become agricultural land may be able to supply mature timber for a number of years, but the supply will run out; so that some other source of supply is necessary. This may be found in the poorer pine lands of the region—those which have been cut over and are now, owing to the frequently recurring fires, almost bare of young growth. Were fires prevented a crop of pine would soon cover such lands and a perpetual supply of pulpwood timber would thus become available in from twenty to thirty years. Some pulp mills desire to purchase such lands in order to be assured of their supply; while others are content to know that near-by landowners are preparing to supply their permanent

demands. Fires in Eastern North Carolina have destroyed and are still destroying the greater part of the young pine growth, but as soon as this can be prevented these poorer lands can be made to pay well in the production of pulpwood. It is only where the assurance of such a permanent supply can be secured that pulp mills can be established, and, for this reason, it is very greatly to the interest of all owners of swamp timber to see that the near-by pine lands are protected from fire.

North Carolina already has a Forest Fire Law which, if enforced, would go a long way towards furnishing adequate protection. All that is needed is an appropriation to put it in force. The next General Assembly will be asked for such an appropriation, and it is confidently hoped that such may be secured.

TILE IN FARM LAND DRAINING*

The farmers of the South are beginning to realize that tile drainage of their farms, when this is done in the proper way, increases very materially the productiveness of their land. This interest has been quickened to such an extent that the demand for tile drainage for farms is very greatly in excess of the number of men who are capable and competent of laying tile to take care of the work. There are a few men in the South who are experts in farm-land draining. I mean by this that they are experienced and competent in the actual laying of the tile so that it will be able to accomplish the work that is expected of it. Tile draining of farm land has in many instances been declared unsuccessful and of no value, and in practically every case it has been due to the fact that the tile was not properly laid. Many farmers, who know that tile draining for farm land is of an advantage to most land, have decided to thus drain their farms, have sent to the factories and bought the tile and then, without any previous experience, have started to lay the tile, and in most cases failure has resulted. In other cases the farmers have taken the precaution to have an engineer lay off a scheme for the tile draining, and then have attempted to lay the tile themselves; and again in many instances the work has been a failure. It needs experienced men to lay the tile just as much as it is necessary that a plan for the tile drainage shall be worked out and a line for the tile be staked out.

I believe the best way to overcome this is for the different States to appoint a Tile Demonstrator, under the Department of Agriculture, whose business shall be to give instructions in the various communities how to lay tile, and the instructions should be given by actual work in laying tile. I believe there are hundreds of thousands of feet of tile to be laid in North Carolina if competent men could be obtained to do the work, and the farmers could be assured that their tile would be laid in the right way.

DRAINAGE CONVENTION

RALEIGH, N. C., February 1, 1917.

In connection with the Drainage Convention that will be held in Raleigh on Thursday, February 1, there will be given in the City Auditorium at 8 o'clock Thursday night an illustrated lecture on what has been accomplished by drainage under the North Carolina Drainage Law in North Carolina during

*Published in *Manufacturers' Record*, February, 1917.

the past few years. This lecture is free, and all who are interested or wish to know something about the swamps of North Carolina are cordially invited to attend. There will be about one hundred pictures shown of the various steps in drainage, and of scenes in the swamps and of the land after it has been drained and cultivated. This is the first time the people of Raleigh have had an opportunity of seeing illustrations of what drainage has accomplished in this State. There will also be a meeting at 3 p. m. in the rooms of the Chamber of Commerce, when the North Carolina Drainage Law will be discussed.

The public is cordially invited to come to the illustrated lecture and see how the North Carolina Drainage Law has increased the wealth of the State by at least \$50,000,000.

MIDWINTER MEETING

OF THE

NORTH CAROLINA DRAINAGE ASSOCIATION

On Tuesday, February 1, 1917, the North Carolina Drainage Association held its Midwinter Meeting at Raleigh, N. C. This meeting was called largely to take up the discussion of the needed amendments to the North Carolina Drainage Law, and also to give information to the members of the General Assembly, and others interested, as to what had been accomplished by reason of the North Carolina Drainage Law.

Among the proposed amendments discussed at the meeting were:

Providing for paying the expense of a preliminary survey;

For a more equitable classification of the land of the drainage districts;

A provision in regard to transfer of land in the districts so that the assessment rolls be made to conform with the present owners of the land;

A provision relating to the election and term of office of the commissioners of a drainage district; length of the term of office, appointment of successors, and what remuneration should be allowed;

A provision relating to the acceptance by the State Treasury of drainage bonds to be deposited by banks, insurance companies, etc.;

A provision authorizing the formation of subdistricts within main districts for the purpose of securing tile drainage;

A provision in regard to the naming of districts, that a district shall be named from the county in which the greater portion of the district is located, together with a number indicating the number of districts in the county; as, for instance, the eight districts of Mecklenburg would be named "Mecklenburg County District, No. 1, 2, 3, 4, 5, 6, 7, and 8."

A provision relating to increasing the number of payments permitted in paying off drainage bonds.

The night session consisted of illustrated lectures on what had been accomplished in the drainage of the swamp lands of Eastern North Carolina. These lectures were given in the City Auditorium, and were well attended by members of the Legislature and others.

The first talk was given by Joseph Hyde Pratt on "What Has Been Accomplished by Drainage." He stated briefly as follows:

"Up to the present time there have been organized 123 drainage districts, 38 of which have been fully organized and the drainage completed; 20 have been completely organized and the drainage work is now being done; 42 are still in process of organization; 11 have been organized, but for one reason or another the work has not started on the ditching and canals; and 12 have been abandoned. Through this work approximately 850,000 acres of swamp land have been reclaimed, and 100,000 acres of overflowed land in Piedmont and Western North Carolina. It is estimated that the cost of draining the swamp land varies from \$4 to \$6 per acre; and for the drainage of the overflowed land in Piedmont and Western North Carolina the cost varies from

\$15 to \$25 or more per acre. The reclamation of these lands means that land which was formerly bringing in no revenue to its owner and was a menace from the standpoint of health is now producing from 40 to 100 bushels of corn per acre, from 1 to 2 bales of cotton, and other crops in like proportion. This reclaimed land, in fact, is the most productive and richest in the State, and will produce in abundance any crop which can be grown in this climate. When it is realized that the taxable value of this land before being drained was from 25 cents to \$1 per acre, that it costs from \$19 to \$31 per acre to drain and clear it, and that after this is done it can be sold at from \$50 to \$150 per acre, some idea can be gained of the tremendous import to the State of draining approximately 800,000 acres of swamp and overflowed land. A conservative estimate of the agricultural value to the people of North Carolina through this drainage work is \$50,000,000, without even taking into consideration the gain from the standpoint of health.

"Cattle raising should and will become a very important industry in Eastern North Carolina just as soon as a stock law is enforced throughout that section of the State. It will be impossible to develop the cattle industry without a stock law. Already the State has lost considerable capital which was ready to invest in large acreage of land upon which to raise cattle. In some instances negotiations were all ready to be closed for the land when it was found that the section in which the land was located had no stock law, and the negotiations were called off. As one cattle raiser expressed it who was contemplating purchasing a large acreage in Hyde County: 'There is no sense in my bringing into Hyde County valuable cattle and raising them when there is no chance of shipping them out.'"

The next speech was by Mr. Willard T. Kyzer, Agricultural Agent of the Norfolk and Southern Railroad, who gave a splendid talk on "The Reclaimed Swamp Lands of Eastern North Carolina." His talk was thoroughly illustrated with splendid views, illustrating the various steps of reclamation of these lands and of the crops that have been and can be raised upon these reclaimed lands.

The last speech was by Mr. D. N. Graves, of Boston, President of the New Holland Farms Company. He gave a most comprehensive and enjoyable talk on the Lake Mattamuskeet District. His pictures showed the various steps in the reclamation of this district.

SUGGESTED LEGISLATION*

In connection with the work of the Legislative Committee of the North Carolina Drainage Association, letters were written to the various bond dealers and others in regard to suggestions as to amendments to the Drainage Law. Letters were received as follows:

LUMBERTON, N. C., January 22, 1917.

DR. JOSEPH HYDE PRATT,
Secretary N. C. Drainage Association,
Chapel Hill, N. C.

DEAR SIR:—Yours of the 20th, *in re* changes in the North Carolina Drainage Laws, at hand, and in reply will say that while I am in full sympathy with any betterment of the Drainage Laws, I hardly think it probable that I will be able to attend the proposed meeting at Raleigh.

Last August, while surveying in the sand hills in Scotland County, I was infected with poison sumach, with disastrous results. I have been laid up since the first of September. Early in December I went to Baltimore for treatment, returning last week, and while I am much improved, I will not be able to get about much before March.

I am greatly interested in the proposed amendments, and should very much like to have a copy of the proposed changes. I might be able to offer some suggestion from my experience here and elsewhere that would be useful.

One thing that would be of help would be some plan whereby one or more of the men who have acted as viewer or commissioner in any district should be available to new districts. In their work they have gained practical experience that is invaluable, and that under the present system is wasted. A viewer or commissioner who has acted for one district has acquired an experience and working knowledge of details and of the laws that will enable him to avoid the delays and blunders that an entirely new set of men will be likely to have. A better way would be to have one commissioner and viewer act for the entire county in all drainage matters, and the other two possibly selected as they now are. That way would insure one experienced member at all times.

I think that Section 31, as amended in 1911, is still susceptible of great improvement. In fact, it is practically impossible to comply with the provisions of Sections 3, 32, and 34, as they are conflicting. Besides that, to at once compute the entire assessment roll for the full ten years entails needless work and expense, for at that time no one knows who or how many will pay at once or how many will let their land be taxed for the bond issue, and the computations made for those parties paying at the outset is time and money thrown away.

The complete assessment roll for the ten years should not be made until *after* the expiration of the fifteen days allowed to pay cash and save the extra

*The amendments to the North Carolina Drainage Law passed by the General Assembly of 1917 are given in Press Bulletin No. 158 of the publications of the Survey.

expense of the bond issue. To be clear and unassailable, those three sections should be rewritten and rearranged. It would not be a difficult matter to so arrange them that there would be no chance to misconstrue the provisions of these sections, and so they would not conflict.

I will do what I can with Senator Gough and Representatives Sellers and Oliver; but to talk to them intelligently I should have a copy of the proposed changes and amendments.

Very respectfully yours,

(Signed) F. F. WETMORE.

GEORGE S. SPEER & CO.
MUNICIPAL AND CORPORATION BONDS
10 South LaSalle Street

CHICAGO, ILL., January 27, 1917.

HON. JOSEPH HYDE PRATT,
Secretary Drainage Association,
Raleigh, N. C.

DEAR MR. PRATT:—From the *Manufacturers' Record* and other sources we understand that you and some of your associates are proposing to ask the State Legislature at its present session to make some changes or amendments in the North Carolina Drainage District law.

If there is time between now and the date you present this matter, I should be glad to have a copy of your proposed amendments, and inclose herewith a memorandum of some of the points which I think most important.

During the past twenty years we have handled sixty-four different issues of drainage bonds, mostly in the Middle West and Southern States. Some of the suggested changes are from the viewpoint of the banker—that is, changes that will tend to make the securities safe and salable. Others are from the viewpoint of the landowner and are intended to create conditions under which landowners under any proposed project that is feasible from a physical or engineering standpoint can safely include their land in the district and depend upon the increased earnings from the soil to meet the obligations when and as due.

You will realize, of course, that anything that tends to make the securities safe and salable will enable the landowners to obtain capital to make the proposed improvements at less cost, and anything that tends to make the operation safe and profitable for the landowner is a benefit to the bank or bond house handling the securities. In other words, their interests are mutual.

The ideal way to obtain money for such improvements is to have the county lend its credit to the proposed district, spread a special assessment on the property to be improved, which will be held by the county, and let the county issue its direct obligations to raise the money to make the improvement. This is done in the State of Minnesota, which has, I believe, the best drainage law of any State in the Union. We also have a precedent in the State of Virginia, where magisterial districts make a special assessment on all property within that district to cover the cost of road improvement. This obligation is held by the county and county bonds are issued and sold to the public to raise the money to do the work. My observation leads me to believe that the State

Legislature of North Carolina would consider this change too radical, and it may be unwise to even suggest that change at this time.

Our interest in the matter arises from the fact that we now own 30,000 acres of land on the Beaufort Peninsula in Carteret County, which we are now draining. When we bought this land we proposed to finance the drainage operation through a municipal district bond issue, but we and our attorneys later found the law to be unsatisfactory, and that operation has been financed by short-time corporation or mortgage bond issue. We now have an option on another and larger tract in the State, which we will buy and develop with a municipal district bond issue if satisfactory amendments to the present law can be had—not otherwise.

On my last trip to North Carolina I tried to arrange to come via Raleigh to talk these matters over with you, but was called home and could not do so, and am therefore sending you this written memorandum, which I realize may be unsatisfactory in that some of the points, or the reasons for suggesting them, may not be clear to you.

These suggested changes are the result of our own experience and observation and also conferences with bond attorneys and other bond houses of experience and who specialize in this line. We consider these changes important, and trust that you and your associates will give them due consideration.

If any of the suggestions are not clear, I should be glad to explain in detail, or make a trip to Raleigh for a conference with you and others interested.

With best wishes, I am,

Yours very truly,

(Signed) G. S. SPEER,
President.

SPENCER & SPENCER

ATTORNEYS AND COUNSELLORS AT LAW

SWANQUARTER, N. C.

January 30, 1917.

DR. JOSEPH HYDE PRATT,

Chapel Hill, N. C.

DEAR SIR:—We have read the proposed amendments to the drainage law, and find that no amendment is proposed to section 30, chapter 442, Public Laws 1909. As this section now reads, we interpret it to mean that after lateral ditches are constructed by the owner of each tract of land, thereafter such lateral ditches shall be kept in repair by the Board of Drainage Commissioners.

To illustrate, suppose A owns a tract of land that is located one-half mile from a drainage canal which has been constructed by the district, and that there are two or three tracts between this tract and a canal. In the event A cannot acquire a right to drain his tract of land through the lands of parties lying between his land and a canal, this section gives him a right to condemn a right of way for his ditch. Now, after this ditch is constructed, section 30 places the same under the control of the Board of Commissioners of the district and compels them to keep same in repair.

You will readily realize that there will be a network of such ditches ranging in size from 1 to 6 feet wide and from 1 to 3 or 4 feet deep. It will be almost impossible for any district to maintain such ditches, and we do not believe

that the spirit of the law contemplates such. However, it would seem from the wording of this section that this duty is put upon the commissioners. We think that this law ought to be amended in such a manner that the owners of land constructing such ditches shall be required to keep the same in repair.

We merely wish to call this to your attention so that the Legislative Committee of the Drainage Association may incorporate it in the amendments if they see fit to do so.

Yours very truly,

(Signed) SPENCER & SPENCER.

SIDNEY SPITZER & Co.

INVESTMENT

MUNICIPAL AND
GOVERNMENT

BONDS

RAILROAD AND
CORPORATION

JOSEPH HYDE PRATT, *State Geologist,*
Raleigh, N. C.

TOLEDO, O., February 1, 1917.

DEAR SIR:—We are in receipt of your telegram of today reading:

“Would you advise longer maturity for North Carolina Drainage Bonds. Are you satisfied with the law as it now stands. Wire quick.”

In reply to which we have wired you as follows:

“We don't advise longer maturities North Carolina Drainage Bonds. We are satisfied with present law and are creating a market for such bonds.”

By way of further explanation, will state that we do not believe that the maturity of the bonds should be changed, because thirteen years is long enough for any drainage bond to run.

We do not know of any suggestions to make as to your laws, as we feel they are good ones, and we have created quite a market for North Carolina Drainage Bonds issued under these laws, and as far as we are concerned we are perfectly satisfied to handle the bonds under the present law.

If we can be of any further service to you, please command us.

Very truly yours,

(Signed) SIDNEY SPITZER & Co.,
By JOHN S. HARRIS.

SUGGESTED CHANGES IN NORTH CAROLINA DRAINAGE DISTRICT LAW

1. Change in the nomenclature. Drainage district bonds should be known by the county in which the property is located. For example: Adams County Municipal Drainage District, No. 1, No. 2, or No. 3, would find a wider market and more ready sale than Alligator Creek or Dismal Swamp Drainage Districts located in Adams County.

2. Extend the time of payment. Drained land gets better each year after it is drained, tamed, and cultivated. There is no reason, therefore, why

municipal drainage district bonds should not run for twenty-five or thirty years, or even longer. The present program of having 10 per cent of the principal mature the third year and 10 per cent each year thereafter is suicidal and is sure to lead to default and bring North Carolina Drainage District bonds into disrepute. Provision should be made for bonds to mature any time within thirty years and stipulate that not more than 10 per cent of the principal could mature in any one year. The district officials and the bond house bidding on the bonds could then agree upon the maturities, date and place of payment of interest and principal within these prescribed limitations. A reasonable amount of flexibility is most desirable.

3. It should be made the duty of the court under which drainage districts are organized to review the proceedings and certify on the back of each bond, when and as issued, that the court has reviewed the proceedings; that the bonds are regularly and legally issued in accordance with the laws of the State of North Carolina, and this certification should by statute make all bonds so certified forever incontestable.

4. Provision should be made for refunding now or at any future time, because bonds of districts organized under the present law are maturing too fast, and unless relief is given in this or some other manner there is sure to be default.

5. Ample provision should be made for the issuance of drainage district bonds to pay for expenditures previously made and work already done, and this provision should be sufficiently broad to enable an individual or corporation to carry on the work as far as possible with their own resources, even to the completion of all construction work, and then issue district bonds to cover the cost thereof. Bonds issued after the construction work is completed can be sold at a much higher price than will be possible to obtain before the work commenced.

6. The interest rate should be 6 per cent payable semiannually, the time and place of payment to be determined by mutual agreement between the district officials and the bank or bond house contracting for the purchase of the securities, and care should be taken to have one installment of the semiannual interest and payments on principal fall due thirty or sixty days after the date when all taxes are supposed to have been paid.

7. All bond issues should be advertised for public sale in local papers and the financial papers in the leading banking centers, and no bid should be accepted below par and accrued interest. If the bonds cannot be sold at par and interest publicly, provision should be made for their sale privately at a price not below 90 or 95 and interest.

8. All assessments for payment of interest and principal on the bonds and the annual maintenance charges should be spread upon the basis of estimated benefits, for two principal reasons: first, because it is equitable, and, second, because it will furnish a financial statement that can be used to advantage by the bank or bond house purchasing the securities, and will, therefore, result in the district obtaining a better price for its bonds.

Ninety per cent of the individual investors who purchase drainage district bonds are accustomed to buying municipal securities, and therefore accustomed the present law the assessed valuation is generally less than the bonded debt. A financial statement of the district would therefore be detrimental.

The district directors or commissioners and the engineer in charge, acting under the direction of the court, should estimate the present value of all land within the proposed district and estimate the value of the land when drained. The difference between the present value and the value when drained would be the amount of the benefit to the property owner, and the estimated cost of the work should be assessed on all property within the district on that basis. A rough illustration of a district containing 25,000 acres will make this point more clearly understood:

Acres	Present Value Per Acre	Estimated Value Drained	Per Acre Benefit	Total Benefit	Per Acre Debt
3,000	\$ 2.00	\$ 70.00	\$ 68.00	\$ 204,000.00	\$ 6.80
5,000	5.00	70.00	65.00	325,000.00	6.50
8,000	7.00	70.00	63.00	504,000.00	6.30
5,000	10.00	70.00	60.00	300,000.00	6.00
4,000	25.00	70.00	45.00	180,000.00	4.50

Estimated cost, \$150,000, or approximately \$6 per acre.

The bond house would have a financial statement of the assessed benefits and the total bonded debt would be approximately 10 per cent of that amount. Again:

Acres	Present Value Per Acre	Estimated Value Drained	Per Acre Benefit	Total Benefit	Per Acre Debt
12,000	\$ 2.00	\$ 75.00	\$ 73.00	\$ 876,000.00	\$ 7.30
5,000	5.00	75.00	70.00	350,000.00	7.00
3,000	10.00	75.00	65.00	195,000.00	6.50
1,500	20.00	75.00	55.00	82,500.00	5.50
1,000	30.00	75.00	45.00	45,000.00	4.50
1,000	40.00	75.00	35.00	35,000.00	3.50
1,000	50.00	75.00	25.00	25,000.00	2.50
500	60.00	75.00	15.00	7,500.00	1.50

Estimated cost, \$160,000.

Average cost per acre, approximately \$6.40.

Maximum assessment, \$7.30 per acre.

Minimum assessment, \$1.50 per acre.

Assessed valuation, according to benefits, more than ten times the amount of the debt.

9. *General Taxes.*—The act should stipulate that there should be no increase in the assessed valuation for general taxes on lands within a drainage district while the drainage bonds remain outstanding, or at least for a period of ten years. This arrangement will work no hardship on the other property owners within the county and will be a great benefit to the district landowners, tend to make the drainage bond a better security, and stimulate development by drainage within the State.

10. The annual tax levied for payment of interest and principal on the bonds and the cost of maintenance should be at least 10 per cent in excess of actual requirements, so as to provide against delinquencies, and this 10 per cent excess assessment should continue throughout the life of the bonds, or until such time as this fund, which will accumulate from year to year, reaches an aggregate in cash of not less than 10 per cent of the face value of all outstanding bonds. Any provision made that will insure prompt payment of interest and principal when due will make North Carolina drainage bonds popular and enable property owners to obtain money to make such improvements at a lower cost than would otherwise be possible.

11. Coupons or bonds that are not paid promptly at maturity should bear interest at the highest legal rate during the period of their delinquency.

12. To insure the levying of assessments and the collection of taxes, the law should impose a penalty on district and county officials who fail to perform their duty in this connection.

13. The assessment necessary to pay principal and interest on the bond issue throughout its life should be spread upon the property within the district at the time the bonds are authorized and issued, and this tax lien should follow the land and not the owner.

14. Shorten the time required for the organization of a district, especially where there is no diversity of ownership, or where all property owners sign the original petition.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of print.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Out of print.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, 50 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, 176 pp., 20 pl., 16 figs., 1 map. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, 124 pp. *Postage 20 cents.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virginina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Out of print.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Out of print.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 64 pp. *Postage 10 cents.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. 8°, 90 pp. *Postage 10 cents.*

46. The Vegetation of Shackleford Bank, by I. W. Lewis, 1917. 8°, 40 pp. 11 plates. *Postage 10 cents.*

47. Proceedings of the Ninth Annual Drainage Convention. Held under the auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Greensboro, N. C., November 22 and 23, 1916. 110 pp., 8 figs. *Postage 10 cents.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy \$1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Out of print.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties. Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Vol. IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley. *In press.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties. Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes. State Geologist, 1896. 8°, 17 pp. *Postage 1 cent:*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp.
Postage 1 cent.

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Upland Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to duth or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount

Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. *Postage 20 cents.*

Administrative Report.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

